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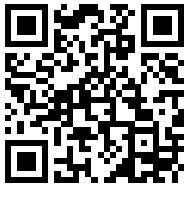

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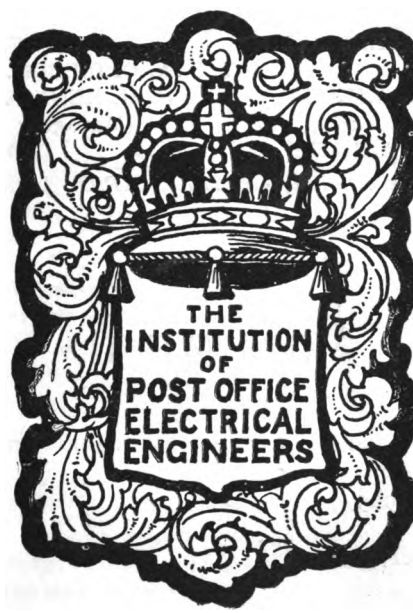

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A QUARTERLY JOURNAL DEVOTED TO:

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CORRECTION.

In No. 3, page 223, line 23, please read "more than π coils per wave length" instead of as printed.

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PAY-DAY—A FAMILIAR SCENE IN THE LIFE OF A TELEGRAPH ENGINEER.

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HARVARD UNIVERSITY
DEPARTMENT OF ENGINEERING.

THE
Post Office Electrical Engineers' Journal.

THE EARLY HISTORY OF WIRELESS TELEGRAPHY.

By J. E. Taylor, A.M.I.E.E.

If an apology is needed for traversing anew the well-worn ground of the history of wireless telegraphy, the excuse that is offered is that, so far as the author is aware, the subject has never been fully treated by any who have been closely associated with the practical development, both of the older electro-magnetic induction systems and the newer radio-telegraphy. Some contributions arising out of much personal experience of both methods of wireless telegraphy may, therefore, not be amiss. The British Post Office can fairly lay claim to have been the home and cradle of practical wireless telegraphy, yet the subject does not appear to have ever been fully presented from the Post Office aspect. Much that has been written, moreover, has been the work either of interested parties exhibiting, consequently, undue bias, or of others who never possessed a working acquaintance with the art. The author has been in direct touch with the practical side of the subject since the year 1895, and had for some years previously closely followed the scientific progress made in Hertzian wave investigations, having specially in view its adaptability to wireless signalling.

Parallel Wire Systems.—Apart from its utilitarian aspect the idea of electrical transmission of signals over a distance without connecting wires has possessed a fascination for the telegraph engineer ever since the early days of the electric telegraph, but no really practical method of doing it was evolved until the Post Office "parallel wire" system was developed. This, of course, is the system which Sir William Preece and Sir John Gavey took an active part in developing. It is so well known that in its main features no description is necessary. With the crude early forms of apparatus used it was found possible to signal over a distance of 3½ miles in the Bristol channel in the year 1892. With the aid of improvements in the type of shore circuit and apparatus used this range of the system has been extended since 1895, and it has been

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applied to bridge distances of some seven or eight miles in the Postal Telegraph System of this country.

BEST CONDITIONS.—In order to obtain the greatest efficiency from the system the following points should be observed:

(*a*) The positions of the shore circuits should be selected so that the spread of the electric current in the sea is diverted by the configuration of the coast towards the communicating circuit as much as possible. If at all feasible, the circuits should be arranged to bridge across tongues of land or headlands so disposed that the greater conductivity of the sea will cause the electric current to spread far out. Making connection of the circuit into the sea by terminating at both ends in the same bay is to be avoided.

(*b*) The circuits should not have more than a few ohms resistance if this condition can be achieved at a reasonable outlay in copper.

(*c*) The receiving telephones should be wound to suit the circuit on which they are used.

(*d*) The interrupter used for sending should be bridged by a suitable condenser, as not only is destructive "arcing" at the segments avoided or minimised, but the signals are very much intensified thereby.

(*e*) The circuits should be erected on poles. Experiment shows that underground wires to the two points where the sea is reached are not so effective. No doubt the greater efficiency of the former arrangement is due to the additional mutual induction between the circuits.

(*f*) The rheotome should be run at a sufficient speed to give from 300 to 500 interruptions per second, and the duration of "make" adjusted to be well in excess of the "break." The human ear is very sensitive to vibrations of about 400 per second, but relatively insensitive to those lower than 300.

For the communication across eight miles of sea between Ballycastle and Rathlin Island, on the north coast of Ireland, a mean transmitted current of about 1 ampère, involving an expenditure of some 30 or 40 watts from dry cells, will produce good workable signals on the telephone receiver at the communicating station in ordinary circumstances. This installation has been in almost daily use since A.D. 1900, and the speed of signalling is only limited by the rate at which the operators can key the messages.

SPEECH TRANSMISSION.—As might be expected, this system is one which lends itself to the transmission of articulate speech. To effect this it is merely necessary to replace the rheotome or current interrupter by a good microphone, preferably of the common battery type, which will make efficient use of a considerable current at 20 or 30 volts E.M.F. Indeed, the only limit beyond that of earth current

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disturbances, to be presently referred to, to this method of communication is the inability of the microphone to efficiently utilise more than about half an ampère of current. So early as A.D. 1894 Sir John Gavey and the late Mr. Matthew Cooper tried this method across Loch Tay, in Scotland, and achieved some measure of success over about a mile of water, but the results were apparently not sufficiently good to warrant the matter being seriously taken up. Improvements in the type of circuit, the windings of the telephone receivers, and the microphone itself, introduced later, put a better complexion on the system however. Following on some tests carried out by the writer on the Menai Straits, near Carnarvon, in A.D. 1900, permission was obtained to try the improved system between the Skerries Lighthouse and Cemlyn, in Anglesey, with promising results. This was promptly followed by its permanent establishment as a means of communication between those places.

CALLING DEVICES.—The history of the development of the Post Office "parallel wire" system would be incomplete without some reference to the several attempts which have been made to equip it with a reliable "calling" device. The absence of some means of calling attention at the stations when a message is to be sent is, of course, a serious weakness, and necessitates a prearranged programme of times at which the operators will be in attendance to exchange signals. This is, at best, a poor alternative to an audible call, such as the ringing of a bell, and curtails the usefulness of the communication very considerably. The addition of such an appliance would, at first sight, appear to warrant little more than ordinary engineering skill; nor is it difficult to introduce apparatus by means of which a bell can be rung, but it is nevertheless a problem of exceptional difficulty to ensure that the bell shall only be rung by the operation of the transmitting station. An occasional false call or two, even, would not altogether destroy the utility of such appliances, but the fact remains that no real success has yet attended the numerous attempts in this direction. One of the earliest of these was made by Mr. Sydney Evershed, who designed an ingenious and highly-sensitive tuned relay, constructed to respond to the transmission of an alternating current of definite frequency. His relay, indeed, closely resembled the modern vibration galvanometers, of which it may be regarded as a forerunner. The marvellous precision with which this instrument could be made to respond to the feeble induction produced by a small bar magnet set in rotation several feet away was extremely striking. Another was designed by Sir Oliver Lodge, and embodied the principles of his magnifying telephone device for relaying and magnifying minute pulsations of current. This also was a highly-tuned appliance, and carried the tuning principle a step further than the Evershed, in that the circuits

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were made electrically resonant to the proper frequency in addition to the mechanical tuning of the apparatus.

EARTH CURRENTS.—The cause of failure in all cases was the existence of erratic and sometimes powerful earth-current disturbances on the circuits. These earth-currents are of a very variable character, and are often far more powerful than any currents generated in the receiver by the operation of the distant transmitter. They are at times so strong as to render the Morse signals in the telephone receiver quite unreadable, and, to whatever cause they may be due, are undoubtedly of the same origin as the well-known atmospheric disturbances which interfere so seriously with the Marconi and similar systems of radio-telegraphy at the present day. There is little doubt that they are closely connected with electrical effects taking place in the atmosphere, probably at a very high altitude, which in turn owe their origin to solar radiation. They produce many characteristic noises in the telephone receiver, likened to the sound of rushing water, bubbling and crackling noises, with, at night (and on occasions during the day), a weird occasional note between a chirp and a moan of varying intensity, but always having approximately the same duration of some three or four seconds. They form an interesting study, and may be observed in their full intensity on any isolated circuit regularly every evening, commencing about an hour before sundown and extending well into the night. In a communication to the Royal Society on the subject (January, 1902), the writer has suggested a meteoric origin for the chirping sounds, and an "ionization" effect in the atmosphere for most of the other noises in evidence. The latter is also thought to be a predominant cause of the diurnal variations of the earth's magnetic field. In fact there is little doubt that the daily fluctuations shown by the magnetic needle are very closely connected with earth-current phenomena. The rapid minute changes of potential at the earth-plates, made evident by the telephone, must involve similarly varying electric currents of no mean order in the crust of the earth and in the seas and oceans. These in turn must of necessity produce similar rapidly fluctuating changes in the earth's magnetic field at the surface, to which, however, the magnetic needle is much too sluggish and insensitive to respond. The telephone may thus be said to render evident rapid diurnal variations of the earth's magnetic field which are not shown by the magnetic needle, to which it should prove a valuable supplementary appliance in researches on this interesting and attractive subject.

INDUCTION *versus* CONDUCTION.—In the past the pros and cons of induction and conduction theories of the "parallel wire" system have been much discussed, but the writer is not aware that any authentic results of tests bearing on this point have been published. Such

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tests have, however, been made, and leave little doubt as to the proper explanation of the action taking place. In the year 1900 tests were made on the Menai Straits, near Carnarvon, in which the relative efficiencies of earthed and non-earthed inducing circuits and of earthed circuits of low and high elevation were accurately determined, the distance between the inducing and induced circuits being a little over half a mile across shallow salt water. The principle of measurement consisted in adjusting the strength of currents in each of the inducing systems under test until equality of signals was observed in the receiving circuits. Arrangements for rapidly switching from one system to the other at one or both sides simultaneously as desired rendered the method of observation a tolerably accurate one. The efficiencies of the systems could then be stated in terms of the strengths of current used for transmitting. In this way an elevated earthed system was shown to be about eighty times as efficient as a vertical closed circuit with its upper part elevated to the same height as the former and its lower part at sea-level. It was also shown that the elevated earthed circuit was some two or three times as effective as the low- or sea-level earthed circuit. There is little doubt, therefore, that both conduction and induction effects were concerned in the results obtained. Indeed, it is pretty obvious that conduction without induction is hardly possible, for the conduction current must carry its magnetic field with it, and this must produce an E.M.F. in the receiving circuit when stopping and starting. It is not possible to determine accurately the leakage current received when passing a steady current in the transmitting circuit, both by reason of variable polarisation of the earth plates and by reason of the presence of variable earth currents which cannot be eliminated or properly allowed for.

Disposition of Circuits.—There can, however, be no question of the benefit derived from disposing the circuits so as to take the fullest advantage of the configuration of the coast, and so materially aid the conduction by suitably diverting the flow or spread of current. This has been done in the cases of the Ballycastle–Rathlin and the Skerries–Anglesey installations, and is no doubt largely accountable for the possibility of signalling with relatively short lengths of line on Rathlin Island and the Skerries respectively, lengths which completely upset the earlier estimates requiring that the line on each coast be not shorter than the actual distance bridged. This point also was investigated in the Carnarvon trials referred to above, and it was found that very poor results attended any attempt to communicate with circuits located where no assistance, but rather the reverse, was rendered by the configuration of the shores. In this way the name "parallel wire system" is rather a misnomer, the wires being usually anything but parallel.

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POSSIBILITIES.—There is one field of possibly useful application for this method of communication which, so far as the writer is aware, has not yet been touched. It should lend itself to a cheap and easy method of communicating from one point to another on tongues of land where a short length of line suffices to bridge across the tongues at each point. In such cases the distribution of the current-spread should be extremely favourable to the communication, and should therefore enable comparatively long distances to be bridged cheaply. Similarly, advantage could be taken for inland communication of neighbouring streams or rivers connected by short lines at the points where communication is desired.

LIMITATIONS.—However, there is little doubt that, so far as any extensive applications are concerned, such systems have been superseded by their newer rival—the Hertzian system. The inexorable laws of Nature step in, decreeing that current-spreading or electromagnetic induction shall attenuate itself as the third power of the distance or thereabouts, whilst radiation of waves shall be attenuated as the distance only. Against such a handicap it is useless to do battle, and radio-telegraphy must perforce hold the field.

TERMINAL LOSSES IN TELEPHONE CIRCUITS.

By A. W. MARTIN, A.M.I.E.E.

BEFORE a magnitude can be definitely expressed it is necessary to fix upon some unit in terms of which the quantity may be measured. Telephone loops differ in their suitability for the transmission of speech, and in order that any two such loops may be compared from an efficiency point of view it is necessary to express each of them in terms of some unit. The unit selected is a mile of lead-covered, paper insulated, copper conductor loop circuit having the following electrical constants:

Conductor resistance	. .	88 ohms per mile of loop.
Electrostatic capacity	. .	0·054 mfs. ,, ,,
Minimum insulation resistance		200 megohms ,, ,,

Such cable is called "standard cable."

If the volume or loudness of speech received at the end of a particular circuit is the same as that received at the end of ten miles of standard cable using the same instruments, the equivalent of the circuit is said to be ten miles; and it is clear that the efficiency of the circuit is inversely proportional to its standard cable equivalent.

The value of any circuit, in terms of standard cable, is determined by means of the method of substitution. A switch is arranged so that two telephone sets may be changed over simultaneously and

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rapidly from the ends of an artificial adjustable standard cable to the ends of a *return* loop of actual circuit between the office, at which the observations are made, and a distant office. One observer counts in a level tone while the other listens and adjusts the equivalent amount of standard cable until equal volumes of sound are received over the artificial and actual circuits respectively. The observers should be so far removed from each other that sounds at the one place do not reach the other except through the telephone circuits.

The results obtained on different classes of circuit with any type of telephone commonly in use in this country are both interesting and instructive.

UNLOADED LINES (*i. e.* circuits which have not had inductance coils inserted in them).—It is found that if the length of the loop be doubled, the amount of standard cable required to obtain a balance of speech volume is also doubled. In fact the standard cable equivalent of any length of a given type of unloaded circuit is directly proportional to its loop mileage. The following series of observed results is but one of a very large number:

Type of unloaded circuit.	Actual length of circuit in miles.	Equivalent mileage of standard cable.
	24·0	10·5
100 lb.	†38·8	17·0
paper core	48·0	21·0
cable	†77·0	34·0
	†115·8	51·0

From the values quoted it will be seen that the first 38·8 miles of actual circuit has the same standard cable equivalent as any *added* equal length (compare results marked †). If these results be shown graphically a straight line passing through the origin is obtained.

Some hundreds of observations have been made upon light and heavy overhead and underground (paper-insulated) loops, between which cases there is, for the same conductor resistance, a variation of from 0·008 to 0·07 mfs. in electrostatic capacity, and 0·004 to 0·001 m.h. in inductance per mile of loop, but in every case the curve showing the result for a particular type of circuit passes through the origin and is a straight line. Of course, by the word *curve* is meant the line, of whatever shape, drawn through the points obtained by experiment.

It is also found that when any number of unloaded circuits are joined in series, the standard cable equivalent of the whole length so formed is equal to the sum of the equivalents of the parts measured separately; at least, no measurable difference is discernible. It

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follows from this that if there be, say, three different loops, A, B, and C, between two places, we may obtain the value of each by measuring:

A + B, say, = 14 miles standard cable.
B + C, ,, ,, 18 ,, ,, ,,
A + C, ,, ,, 22 ,, ,, ,,

from which—

A = 9, B = 5, C = 13

LOADED LINES.—The behaviour of loaded lines, however, is slightly different from that of unloaded ones. It is found, if ordinary telephones be directly connected to the lines, that the cable equivalent of the first length is apparently greater than that of any equal length of similar circuit added in series.

Taking the same cable as before, the following values for different lengths are obtained, an average of 42 millihenries having been added to each mile of cable:

Type of loaded circuit.	Actual length of circuit in miles.	Equivalent mileage of standard cable.
100 lb.	77·0	14·8
paper core	154·0	23·1
cable	231·0	31·9
42 m.h. per mile	308·0	41·5

Note.—The decimal points in column 3 are due to the calibration of the particular standard cable used.

To save space only four observations are quoted above, although a large number of observations have been made. It will be seen that the first 77 miles of circuit has an equivalent of 14·8 miles of standard cable, but that each 77 miles added only increases the equivalent by 9 miles (mean). There is therefore a factor which appears with the first length observed upon, and which remains constant no matter how much the length of circuit be increased provided its character remains unchanged, *i.e.* that the added lengths are of the same type and loaded like the first.

The curve of the results is a straight line crossing the abscissa line at a point such that its distance from the origin represents the difference between the standard cable value of the first length measured and that of any added equal length. Since this difference does not increase with the length of the circuit it must be due to something independent of the cable length—that is, it must be an end or *terminal loss*. That it is a loss will be clear from the fact that its effect is the same as interposing a length of standard cable in the circuit.

Terminal loss is experienced upon all loaded lines, and is due to the fact that existing apparatus was designed to utilise the electric energy transmitted over unloaded circuits, in which the ratio of electrostatic to electro-magnetic energy is very different from that

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obtaining in loaded ones. When a line is loaded there is a greater proportion of electro-magnetic energy than before and the apparatus does not utilise the whole; some is reflected. This reflection means so much loss at the receiving end.

It must not be inferred that there is any necessity to change the design of apparatus at present. It is only circuits such as trunk lines and long junctions which require improvement by loading, and such circuits are usually extended to local subscribers. Terminal loss is always reduced and sometimes eliminated when a loaded line is extended by unloaded circuits at each end, provided the extension lines possess appreciable electrostatic capacity.

Some very promising results have been obtained in connection with terminal loss removal by bridging capacity across the lines close to the apparatus, and, in the alternative, by inserting a special transformer between the apparatus and the loaded line, but space does not allow of the discussion of these points at present.

If a circuit which possesses considerably more inductance than the average unloaded line is subject to terminal loss when the ordinary forms of apparatus are used, it would appear that a circuit having an abnormal electrostatic capacity should also show such loss. Some experiments have been made, but more are required to determine the point; the results, as far as they go, indicate that terminal loss does occur on circuits of electrostatic capacity equal to about 0·18 m.f. per mile of loop. The results of one such experiment are as follows:

Three circuits were taken, two of which, A and B, were 40 lb. conductor loops of equal length, with a wire-to-wire capacity of 0·06 m.f. per mile. The third, C, was a loop of 120 lb. conductors, having a capacity of 0·18 m.f. per mile of loop.

The measurements of the circuit separately were:

A = 11·7 miles of standard cable.
B = 11·7 ,, ,, ,,
D = 25 ,, ,, ,,

Joined in series A + B measured 23·4 miles of standard cable, so that no terminal loss occurred in this case; but on joining the three loops in series in the order A + D + B the equivalent obtained was only 44·4 miles of standard cable, or a saving of four miles on the sum of the parts. This is possibly due to the presence of terminal loss on the high capacity circuit D, when separately measured, and to the fact that such loss was reduced or eliminated when the length was terminated by loops of normal electrical constants, in the same way that such extensions remove terminal loss from loaded lines of relatively great inductance per mile.

From what has been stated under the heading of *unloaded lines*, it will have been gathered that no terminal loss has been observed on

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the lines generally in use, all of which have electrostatic capacities per mile much below 0·13 m.f., although their conductor resistances vary very considerably. It does not follow from this that there is no actual terminal loss; it is not noticeable because one unloaded circuit is compared with another—*i.e.* standard cable, which, if it has terminal loss, possesses it in a degree commensurable with that possessed by all other commonly used unloaded lines.

LIVERPOOL TRUNK EXCHANGE NEW EQUIPMENT.

By J. S. Brown.

In continuance of the policy of providing in the larger zone centres trunk switching equipment of fireproof construction, and of the lamp signalling common battery type giving each trunk operator full junction and transfer multiple facilities, the Department has recently replaced in Liverpool the old wood sections, which only provided a partial junction and transfer multiple, by the latest type of iron frame, 3-panel trunk and junction switch sections. The new equipment comprises a fuse-board (1169 fuses), trunk and junction intermediate distributing frames, trunk and junction relay racks, time check cabinet, cable troughings, and forty-two 3-panel trunk and junction switch sections—providing accommodation for 420 trunk circuits—and two supervisors' desks. The test-board, record transfer and local sections, and record table and fittings were of recent type, and beyond changing the voltage of the speaking sets from 4 volts to 24 volts, remain without further alteration.

The Plan shows the exchange lay-out. The forty-two switch sections forming the present installation occupy three sides of a rectangle, the two long sides of which can be extended when the traffic warrants an increase in the number of switch sections, whilst the fourth side is occupied by a small local section (C.B.S.) for 200 lines together with the record transfer section and a Dey time-register.

The test and apparatus room are adjacent to the switch room and divided from it by the sections and a partition. Owing to the noise caused by the driving mechanism the time check apparatus is placed in the linemen's room, which is readily accessible from the switch room.

The sections are of iron, faced with mahogany; the suite forms a very effective *tout ensemble*, and as there is a clear width of 28′ 6″ between the sections the switch room has no appearance of being crowded.

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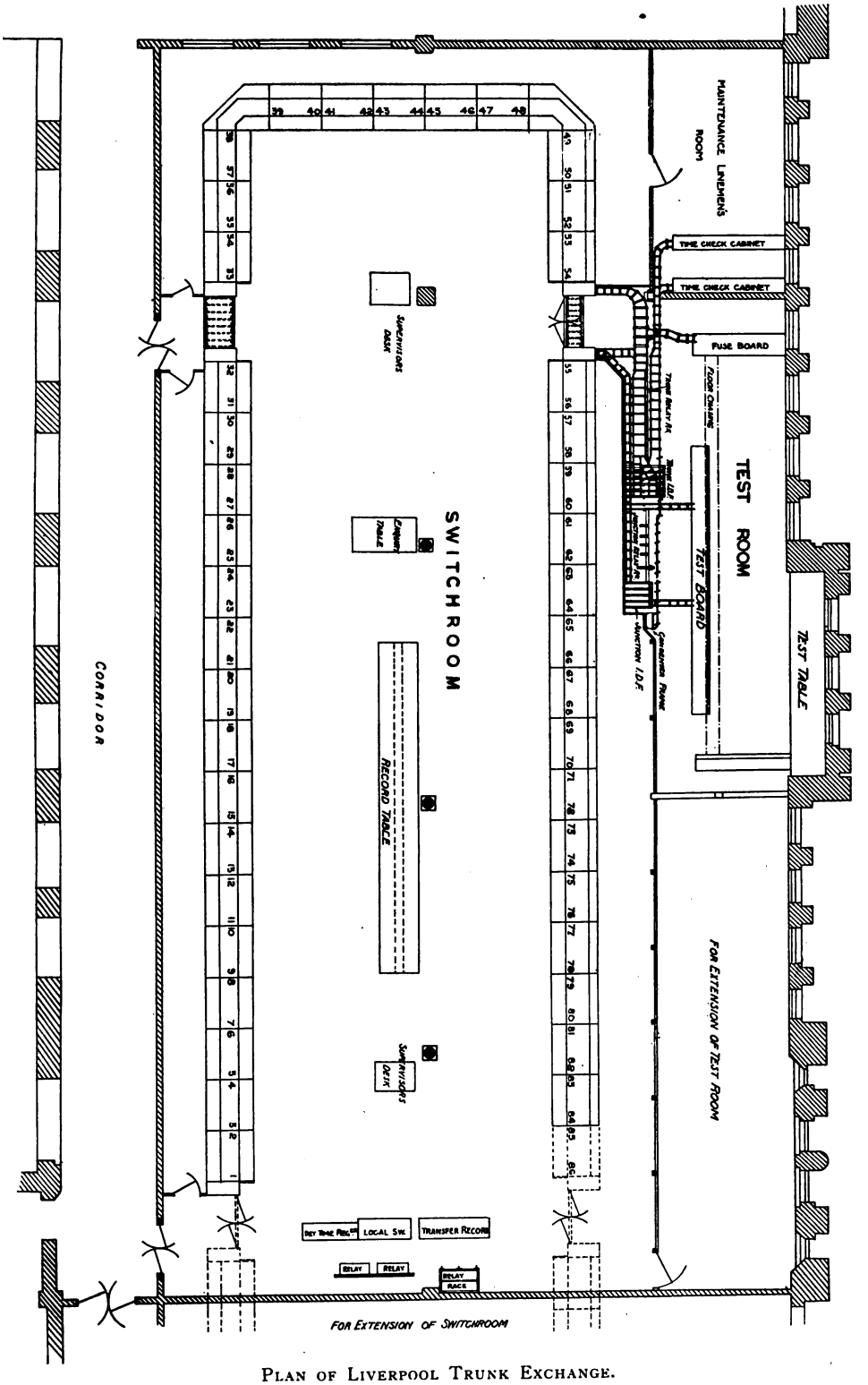

PLAN OF LIVERPOOL TRUNK EXCHANGE.

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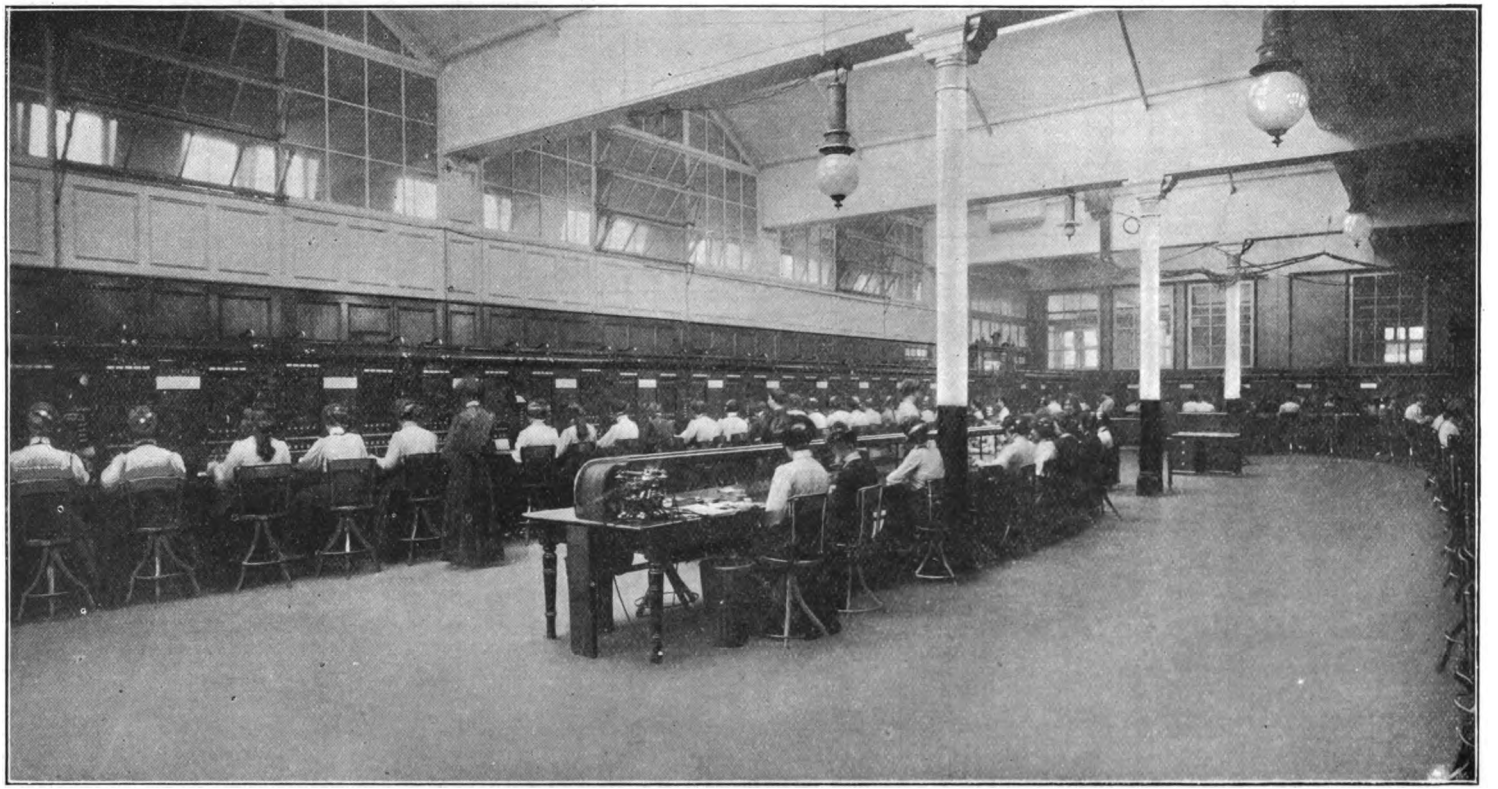

Liverpool Trunk Telephone Switch Room.

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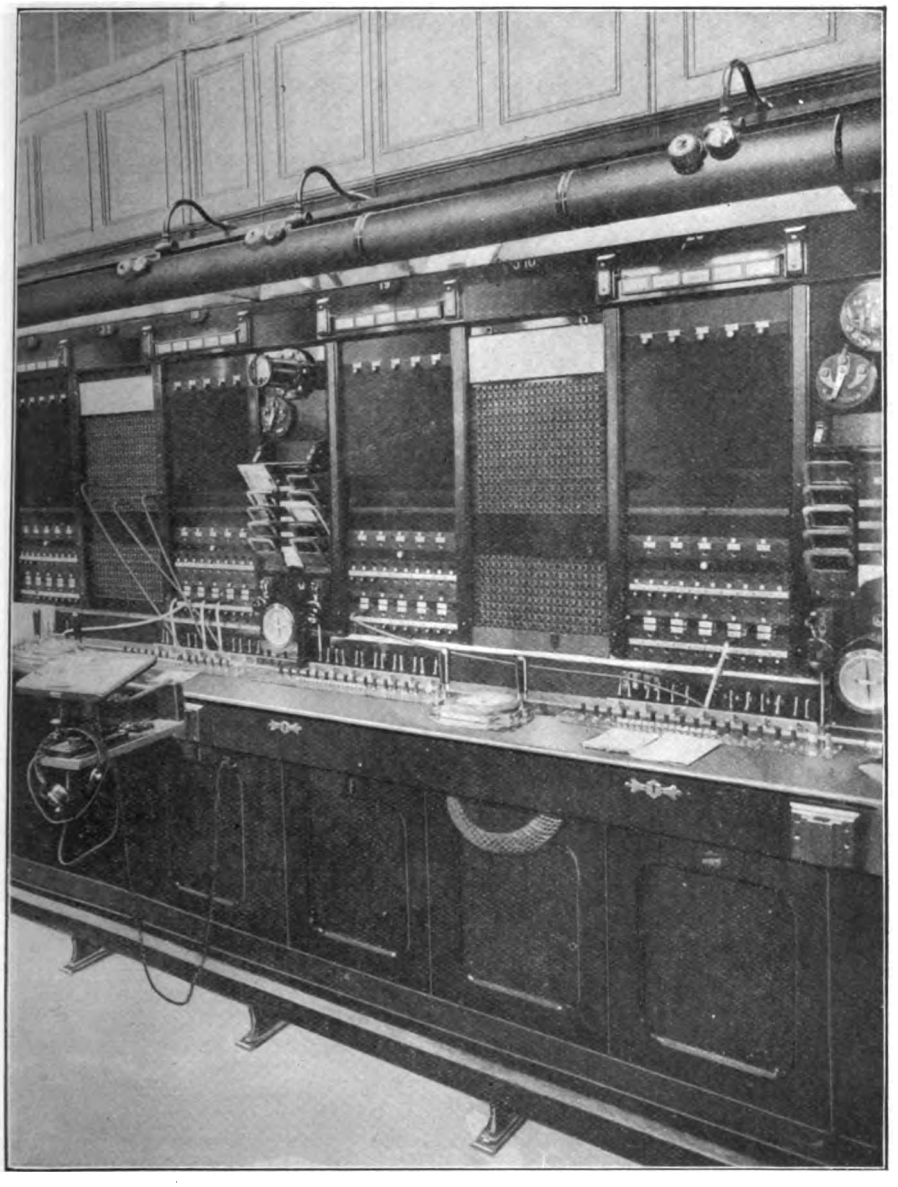

LIVERPOOL TELEPHONE EXCHANGE NEW TRUNK SWITCH SECTION.

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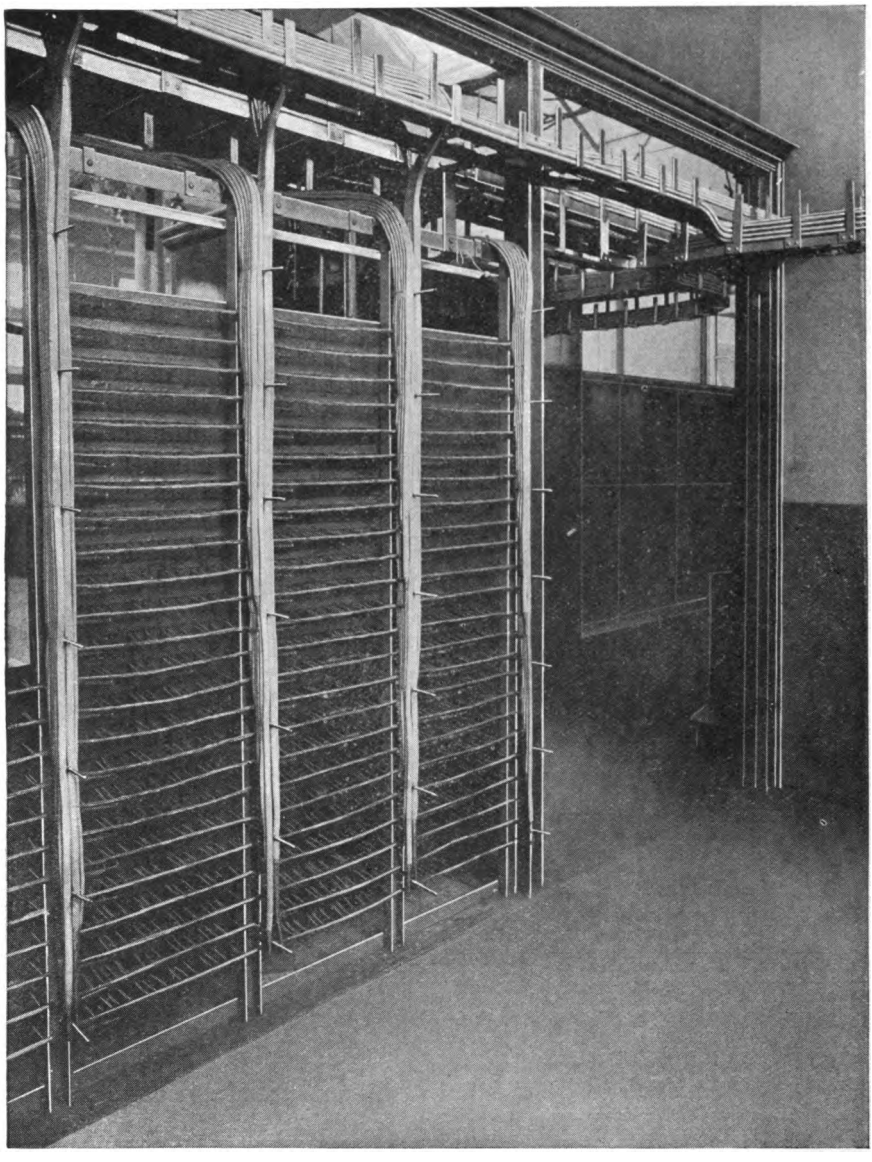

3.—Liverpool Trunk Exchange: Line Relay Rack and Cable Runs.

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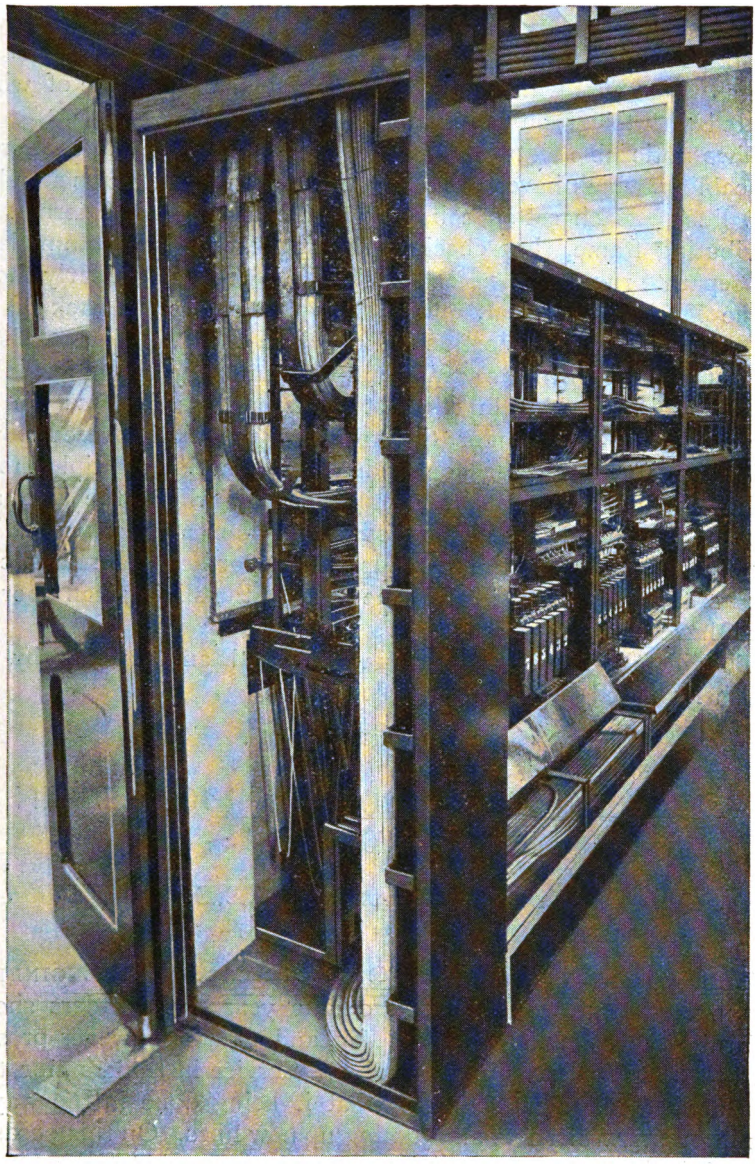

4.—Liverpool Trunk Exchange: Cable Turning Section and Rear of Switchboard.

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1 shows a general view of the switch room. The table in the centre of the room is the record table at which requests for trunk service are received by operators who make out tickets and place them on the travelling band. They are carried by it to the end of the table and thence by hand to the switching operators. 2 shows two 3-panel trunk and junction switch sections, one of which is fitted with telegraph call wire apparatus.

Two noticeable features of the new equipment are the cable runs and cabling, which have been arranged as far as possible on standard C.B. lines. Each set of cables from the fuse-board, intermediate distributing frame, time checks, relay racks, etc., is accommodated in a separate run, the general principle followed being clearly shown in the Exchange lay-out, and in 3, which shows the back of the line relay rack and a portion of the fuse-board, whilst 4 shows one of the cable-turning sections and the run of the cables inside the sections. The cables in the last figure are as follows: On the hangers immediately under the roof are the lead-covered power cables; the upper shelf accommodates the junction multiple cables, the lower shelf the transfer multiple cables, whilst the line and concentration cables are accommodated in the cable boxing at the rear of the bottom of the sections. The cord-circuit relays, condensers, etc., can be seen inside the section, the sliding iron doors of which have been removed.

The installation has been manufactured and erected by the British Insulated and Helsby Cables, Ltd.

A YEAR'S TELEPHONE PROGRESS IN LONDON.

By G. F. Preston, M.I.E.E.,
General Manager Post Office London Telephone Service.

The Editors of the Post Office Electrical Engineers' Journal evidently consider that once a year their readers should be furnished with facts, however dry, and figures, however prosaic, relating to the Post Office Telephone Service in London, for they have again demanded to know what is being done in the way of opening up new districts and joining up new lines. On this occasion the task is, in one sense, a lighter one, as the period to be covered comprises one year only, viz. that ended December 31st, 1908, whereas it may perhaps be remembered that last year's article treated of the development of the system, year by year, from its inception in 1902 to the end of 1907.

Last year's work, as revealed in the cold light of official figures,

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which, like facts, are "chiels that winna ding," show that the excellent progress previously chronicled has been maintained. It is all the more satisfactory to record this when regard is had to the general depression of trade during the year, a factor which seems to have exercised a prejudicial effect in very many fields of commercial enterprise. Readers of the JOURNAL have, no doubt, observed the frequency with which inquiring shareholders at recent company meetings, where inadequate excess of revenue over expenditure had to be reported, were met with the statement that depression of trade was responsible for the lessened earnings. Although possibly the fact was unduly emphasised in some cases, it cannot be gainsaid that trade during the year was far from flourishing.

The wave of trade depression was not sufficient, however, to stop the steady flow of progress of the Post Office Telephone System in London, although, as will be shown hereafter, it was responsible for a larger number of lines being given up than usual, and for a slight reduction in the net rate of increase. The following table shows the number of direct lines and stations concerned with each Post Office Exchange in London at the end of 1908, and the position as compared with the previous year. It will be seen that increases were made in every case—with the single exception of Central, whose case will be explained subsequently—and that the total increase in the number of stations was no less than 5831. This figure, it is true, is not quite so large as the increase of 1907 over 1906. The difference—5831, as compared with 5872—is, however, slight, and there is no doubt that it would have been on the right side had it not been for the abnormal number of cessations, and had the Department not been forced, from causes which need not be enumerated here, to slacken the output of energy for new orders in certain districts.

There is no need for alarm at the decrease shown in the case of the Department's largest exchange. It does not mean that the Post Office is losing ground in the heart of the Metropolis. All that it does mean, indeed, is that the Department found it convenient and desirable during the year, owing to heavy traffic on certain of the operators' positions at the Central Exchange, to join up lines to the new City Exchange which would otherwise have taken the places on the Central positions of removed Central lines.

The resultant decrease of Central lines is fictitious, as showing movement in the Central area, just as much as the large increase shown in the case of the City Exchange is fictitious. The two Exchanges serve the same area, and they should be grouped together in order to see the growth of the system in that area.

It is somewhat difficult to compare the progress of the Post Office system in London with that of the National Telephone Company

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Table showing Increases of Lines and Stations on P. O. London Telephone Service during 1908.

Exchange.	Lines working on 31st December, 1908.	Increase over 1907.	Stations working on 31st December, 1908.	Increase over 1907.
Barnet	96	83	103	89
Central	14073	decrease 623	22111	decrease 182
City	1507	1378	2125	1955
*Central and City combined	15580	755	24236	1773
Chiswick	799	90	905	98
Croydon	617	64	675	75
Ealing	650	71	730	90
Epsom	170	25	187	34
Esher	95	33	101	36
Finchley	156	134	175	152
Hampstead	3425	430	3791	485
Harrow	222	64	264	79
Hornsey	681	394	739	433
Hounslow	121	20	142	22
Kingston	847	64	981	79
Malden	51	26	54	27
Mayfair	3861	313	5239	532
Mitcham	40	40	47	47
Official Switch	187	40	296	60
Putney	1046	120	1165	129
Richmond	768	73	873	74
Southall	21	14	23	14
Sutton	418	73	443	81
Treasury	151	15	206	36
Trunk	98	—	125	3
Victoria	2735	284	4886	620
Wembley	59	18	86	24
Western	4102	405	4769	555
Willesden	350	118	375	125
Wimbledon	718	51	806	59
Total	38064	3817	52422	5831

* These two exchanges are in one building.

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owing to the disparity in size between the two systems, National Exchanges in the area numbering fifty-nine, as against twenty-six Post Office Exchanges. The aggregate number of stations joined up last year to the Company's Exchanges was greater than the number joined up to the Post Office system, but it is not fair to argue from this fact that the Company is making faster progress than the Post Office. As a matter of figures, taking the two systems as they stood at the end of 1907, and regarding the number of stations added to each during 1908, it is found that the rate of increase on the Post Office system was greater by 1½ per cent. than that of its older rival.

Year by year old subscribers leave the system for various reasons. The disappearance of a certain number of subscribers is, of course, inevitable with every telephone system. If the system is a healthy one this number is, or should be, limited, and it is, or should be, small as compared with the number of incoming subscribers. Last year the number of subscribers giving up their Post Office telephones in London was the largest yet recorded in the history of the system. The actual figure as shown by the official records was 2544. Although this number does not amount to 7 per cent. of the lines working, it is too large to be passed without special analysis. A record is kept of the reason or reasons given by every subscriber on the Post Office system who gives up the installation, and a summary of the results is subjoined, together with the previous year's figures.

Year.	(1) Deaths.	(2) Bankruptcies.	(3) Giving up business.	(4) Removed, unknown.	(5) Business bad.	(6) Leaving area.	(7) Miscellaneous.	(8) Total.
1907	79	162	159	296	488	353	558	2095
1908	68	226	188	516	788	308	450	2544

The Bankruptcies and Bad Business cases seem, *primâ facie*, cases of discontinuance through depression of trade. At the same time, it does not follow that each Bankruptcy or Bad Business case is due to general trade depression. Cases under these headings may, and do, arise during times of national prosperity where the depression is purely local and independent of the general trend. But the great increases in Bankruptcy cases (84, or over 50 per cent.) and in Bad Business cases (300, or over 61 per cent.) point unmistakably to a wave of severe general depression last year.

A large proportion of the "recoveries" indicated by the figures in Columns 3 and 4 were, no doubt, due to trade depression. Taking 80 per cent. of the figures in each case as representing cases of removal due to this cause—the percentage should probably be fixed higher than this—and adding to the result the Bankruptcy and Bad

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Business cases, we obtain for the year 1908 a total of 1577 "recoveries" out of 2544, or over 60 per cent. of the total number, due to trade depression, as compared with 273 out of 2095, or 44 per cent. in the case of 1907.

In connection with this point the National Telephone Company's figures for the year 1908 are of considerable interest. Last year the total number of cessations on their whole system—London and Provinces—was no less than 28,281, an increase of over 3000 on the figure for the previous year. The increase in the number of cessations was attributed by Mr. Franklin at the Company's Annual Meeting chiefly to the fall in trade during the year.

It is always instructive to watch the extent to which the average subscriber is using his telephone, to watch the gradual strengthening of the hold of the telephone habit on him. As a rule, wherever the telephone gains an entrance it stays and flourishes. A single Exchange line is followed by extensions, the Exchange line cannot cope successfully with the increased traffic, another Exchange line follows, and so a private Branch Exchange is built up. Not only does the number of lines increase, but the user of each line increases. This increase of user is one of the significant facts in connection with London telephones. One takes a telephone first of all with the idea that it will be convenient at times, or perhaps to get rid of the importunate canvasser, who has become wearisome in his importunity, or perhaps on the recommendation of some people who want to get at him quickly. Gradually he finds that the instrument saves a good deal of correspondence, that it is useful in cases of emergency, that it is convenient for people who would otherwise write.

The use of the circuit increases; the subscriber is using it more this year than a year ago, he will use it next year and the year after more than to-day.

The following figures, which are taken from the last general observation, taken towards the close of 1908, show the average number of calls per exchange line per day in the case of the Department's Chief Exchanges in London. For the purpose of comparison the corresponding figures for the previous year are added :

	1908.	1907.
Central	7·2	6·81
City	5·5	—
Victoria	5·3	4·8
Mayfair	4·8	4·5
Hampstead	3·2	3·1
Western	3·3	4·0

The review of the year would not be complete without some reference to the Department's enterprise in opening an Exchange in connection with the Franco-British Exhibition, enterprise which was

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fully justified by the results. Over 100 subscribers were obtained, and as each of the subscribers was what is known as a "busy subscriber" the revenue in fees, in addition to the rental revenue, was very satisfactory. In addition some £400 was taken in twopences by the two dozen automatic call boxes distributed, by arrangement with Mr. Imre Kiralfy, at various points throughout the Exhibition. It is somewhat early to estimate probable results in connection with this year's Exhibition, the Imperial International, but if the undertaking is at all successful the telephone results should be even more satisfactory than those of last year.

TRAWLERS AND CABLES.

By T. B. BRAUND.

"There is no sound, no echo of sound, in the deserts of the deep,
On the great grey level plains of ooze, where the shell-burred cables creep."
RUDYARD KIPLING.

THE submarine cable engineer encounters difficulties which do not often beset the path of his *confrère* in the land telegraph service, and he has a class of troubles entirely his own. Comparatively few telegraph engineers, for instance, are disturbed by the work of the Teredo navalis—*et hoc genus omne*—or by ships' anchors, shipwrecks, or even sea-quakes (if the term may be allowed), but all these enter with more or less persistency into the life of the cable engineer. The Submarine Department of the British Post Office, which maintains cables to Germany, Holland, Belgium and France, to the Channel Islands in the south, Ireland in the west, and the Shetland Isles in the north, has found that its cables suffer most interruption owing to anchor damage, about 45 per cent. of the total number of faults being due to this cause. So severe is the damage thus occasioned that the sheathing wires are sometimes stripped off and the gutta percha laid bare for a considerable length, the cable being in fact all "birdcaged up." As an instance of this class of breakage it may be mentioned that R.M.S. "Saxon" about seven years ago caught her anchor in the Isle of Wight telephone cable, and owing to the severe weather conditions pulled the cable from the shore on both sides into the middle of the Solent. Other causes of faults so far as the Post Office cables are concerned are the above mentioned Teredo (although since the cables have been brass-taped this little borer has been checkmated), chafe owing to the condition of the sea-bottom, faults in manufacture, natural decay, and shipwreck on the cable.

The principal cable companies, however, have from time to time during the past few years bitterly complained that of all the ills to

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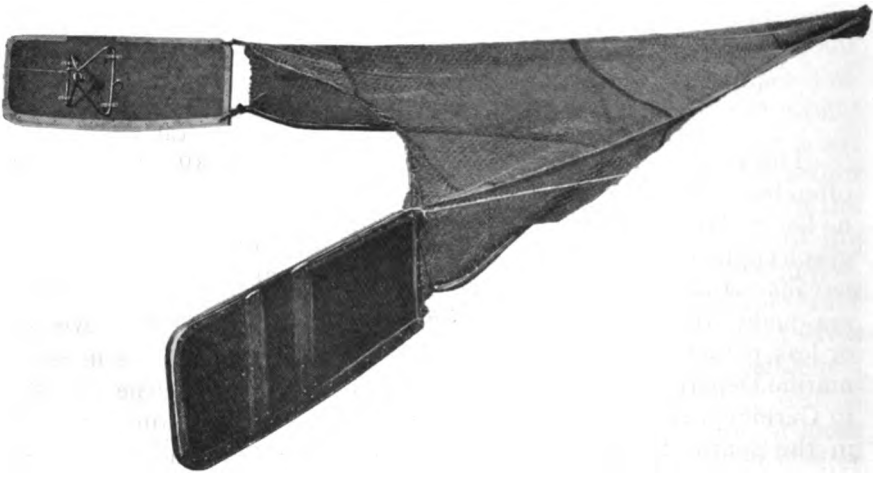
which their cables are heir, damage by trawlers is the most serious and certainly the most disheartening. It is disheartening because no sooner has the cable-ship removed a fault and returned to her headquarters than a trawler may again damage the cable at the identical place. A sympathetic Government heard their complaints and appointed a committee "to inquire whether injury is caused to submarine cables by the operations of trawlers, and if so, to consider and report what steps it is desirable and practicable to take to prevent such injury." Sir John Cameron Lamb, C.B., C.M.G., the well-known ex-Second Secretary to the Post Office, was appointed Chairman, Mr. W. R. Culley, I.S.O., the *doyen* of Post Office cable work, was a member, whilst representatives of the Board of Trade, Admiralty, and the English and Irish Fisheries were also appointed. Witnesses from the principal cable companies, representatives of the



1.—Trawl-net.

steam trawling industry who clearly proved the magnitude of the interests they represented, and owners and skippers of trawlers, whose evidence smacked of the sea, having been examined, the Committee have issued a most valuable and interesting report, and their recommendations when adopted will, we think, have the effect of establishing amicable relations between the interests concerned.

The complaint of the companies was that their cables, principally those landing in the neighbourhood of Valentia Island, off the south-west coast of Ireland, were frequently damaged by the otter boards forming part of the trawling gear of the fishermen, a type of which is shown in 1. These otter boards are about 10 feet long by 4 feet wide and weigh about 14 cwt., and whilst it was agreed that they might pass over a cable many times without damaging it, yet it was thought that if for some reason the board lay flat on the

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bed of the sea, a cable could easily become fixed between the bracket and the otter board itself. The Committee came to the conclusion that the normal position of the boards during the operation of trawling is almost vertical, and they are dragged along at an angle of about 45° to the line of progression, their kite-like action keeping the mouth of the net well open. Moreover, they do not as a rule "plough along" heavily, but dance or "shiver" as they advance, and this being so a board in good condition and operated properly would not in all probability injure a submarine cable. Unfortunately the evidence proved that the condition of the otter boards is not always all that it should be, the heads of some boards in use having large notches in them which could very conceivably grip a cable. Further, the "shoe" or iron band at the base of the otter board is not always smooth, there being in some cases bolts projecting which might cause injury. The cable companies suggested several remedies, including a thorough inspection of all trawling gear and prohibition of trawling in the cable area.

This latter recommendation the fishermen strenuously opposed (and we must admit with every show of reason), evidently holding the view—

"The hollow oak our palace is,
Our heritage the sea."

and advancing a *tu quoque* argument to the effect that the cable companies damaged their own cables by their grappling operations during a repair. Types of the grapnels used by the cable ships are shown in **2–5**, and whilst these are, indeed, formidable weapons, weighing, as they do, between 2 and 3 cwt., it was pointed out to the witnesses that the damage of which complaint was made was always caused before the cable ship commenced operations.

It appears clear from the evidence of the owners and skippers of the trawlers that they do not wittingly damage the cables. They are aware of the terms of the Submarine Telegraphs Convention, whereby "Any owners of ships or vessels who can prove that they have sacrificed an anchor, a net, or other fishing gear in order to avoid injuring a submarine cable shall receive compensation from the owner of the cable," and that they comply with the terms of the Convention is partly proved by the fact that the Post Office is frequently called upon to settle claims of this character, and enjoys comparative immunity from interruption of its own cables in the trawling area of the North Sea.

It was represented to the Committee that if the cables did not lie on the bed of the ocean but formed bridges across the submarine valleys, then it was scarcely to be expected that the otter boards should not engage them, but it was ascertained that the cable companies make every endeavour to secure that their cables are not laid in this

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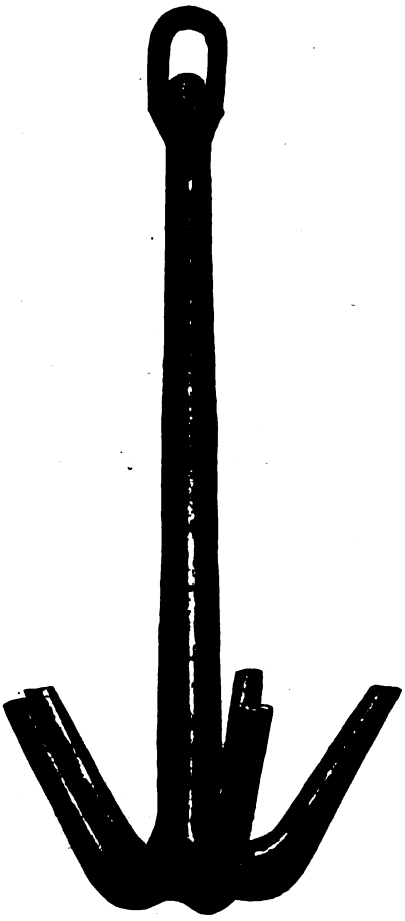
manner, and to this end careful surveys of the bed of the sea are made. This explanation should be a source of satisfaction to one witness, who had a suspicion that the percentage of slack usually allowed when a cable was laid was not apportioned evenly over the



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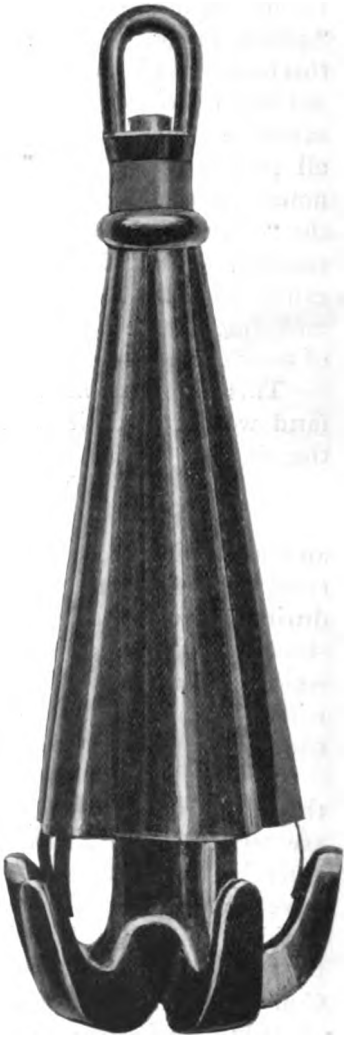

3

CABLE GRAPNELS.

whole length, but that when a mile or so of cable had been laid a piece representing, say, 5 per cent. of slack was thrown overboard and formed a loop on the bottom.

The fishermen made many suggestions for avoiding damage to the cables by the otter boards, and they seemed prepared to accept

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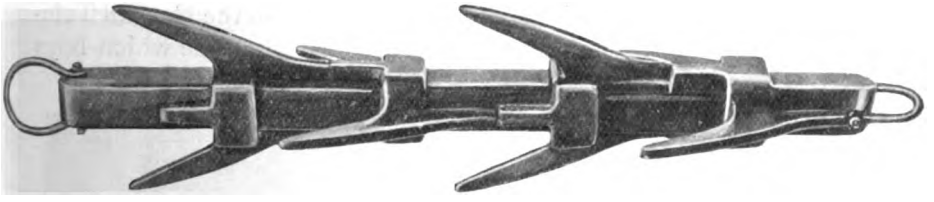
anything but the dreaded proscription of area. "Why should not the cables be buoyed so that the trawlers might avoid them during their operations?" suggested one witness, while another proposed that the Government "might make a good subscription towards the Marconi system being perfected, then there can be no such damage." One of the most practical recommendations was that the cable companies should consider the question of substituting heavier types of cable in the trawling zones, and this has been endorsed by the Committee.

Steering a middle course between the suggestions of prohibition of trawling in the cable area and the various suggestions of the trawling industry, the Committee must be congratulated upon having arrived at a decision which cannot fail to be satisfactory to both parties. They are of opinion that injury is sometimes caused to submarine cables by otter boards of certain types and boards out of repair, and they recommend that a system of Government inspec-



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5

CABLE GRAPNELS.

tion of the gear of trawlers be at once instituted, and that all cable companies should (as certain companies and the Post Office have already done) establish friendly relations with the fishermen who frequent the waters in which their cables are laid. The first of these recommendations has already received the approval of the representatives of the trawling industry, and its effect will be to secure that all attachments to the otter boards, "whether brackets or chains, should be as simple and smooth as possible," since "*in every part of the board the aim ought to be to afford no resting place for a cable if it should chance to be caught.*"

The Committee has further recommended that steps be taken, through the diplomatic channel, to invite neighbouring foreign states to adopt a similar system of inspection, and they have placed on record their warm thanks to their Secretary, Mr. F. J. Brown, for his zealous and able co-operation, whilst I have to thank Mr. Culley for kindly furnishing me with information respecting the types of grapnels here illustrated.

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PNEUMATIC TUBE SERVICES.

By D. H. KENNEDY, A.M.I.E.E.

IN all large towns of the United Kingdom the Post Office has used pneumatic tube services as a valuable auxiliary to the telegraph system. In London, for instance, the principal offices in the City and West End, the House of Commons and the various cable companies are connected with the Central Telegraph Office by tubes, which carry an average number of 50,000 messages daily. The point from which these tubes radiate is the Central Hall at St. Martin's-le-Grand (1), and in the illustration the long-distance tubes can be seen at the rear. The same system is applied to facilitate the conveyance of messages from point to point within the Central Telegraph Office, and the table in the centre of 1 alongside which boys

1

in telegraph messenger uniform are seated, is the House Tube table, the tube termini in this case being arranged horizontally instead of vertically.

In the majority of cases only one tube is provided between the central station and the outlying office, this tube being worked in both directions, but where the work demands it two tubes, worked "up" and "down," are used. In the latter case a special form of signalling apparatus is introduced, which enables a series of "carriers"—separated by definite time intervals—to be kept running simultaneously through the tube, so that it is not necessary to wait for the arrival of the first carrier before the second one is inserted. On the other hand, the carriers must not be allowed to follow each other

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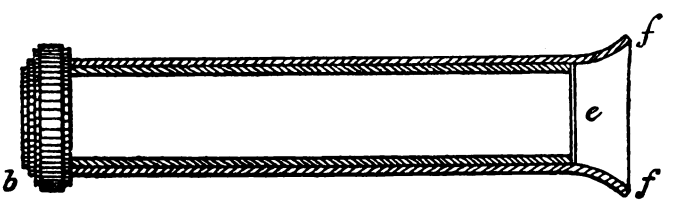
without a sufficient interval, or the second will overtake the first and a stoppage may result.

Carriers.—The carriers (2) in which the messages are placed are made of tubes of gutta-percha covered with felt. The felt has a skirt, which projects beyond the gutta-percha body and protects the message-forms should they not be closely folded. The front is provided with a buffer, formed of discs of felt exactly fitting the tube. A carrier for a $2\frac{1}{4}$ in. tube will hold twenty-five telegraph forms, and when fully loaded weighs about 6 oz. To retain messages in the carrier an elastic band (*e*) is used, stretched over the mouth of the gutta-percha body.

The long tubes are usually $2\frac{1}{4}$ in. internal diameter, and in some cases 3 in. For house-tubes $2\frac{1}{4}$, 2 and $1\frac{1}{2}$ in. diameters are used. The $2\frac{1}{4}$ in. street-tubes are of lead, weighing 21 lb. to the yard. They are enclosed in 3-in. diameter cast-iron pipes, buried to a depth of 3 ft. below the pavement. The method of laying is similar to that followed in ordinary underground telegraph construction, with the



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addition that when three iron pipes have been jointed they are drawn over a length of lead pipe. The length of jointed iron pipe containing the lead tube is then lowered into the trench, and the ends of the lead tubes butted together, a distance of 1 ft. being left between the ends of the iron tubes. A polished steel mandrel, 6 in. long and slightly less in diameter than the lead tube, is heated and pushed half its length into the tube already laid. A chain attached to the mandrel is passed through the length of tube about to be laid, to enable the mandrel to be withdrawn later, and the new length of tube is forced over the projecting end of the mandrel until the tube ends butt perfectly together. An ordinary plumber's joint is then made, and the mandrel withdrawn by means of the chain to the point where the next length is to be jointed on. As far as possible the tubes are laid in a straight line; in other cases they form a circular arc with as great a radius as possible.

The motive power for working in both directions is situated at the central point, the outgoing carriers being propelled by a pressure of 10 to 15 lb. per sq. in., and incoming carriers by a vacuum of 7 to 10 lb. per sq. in.

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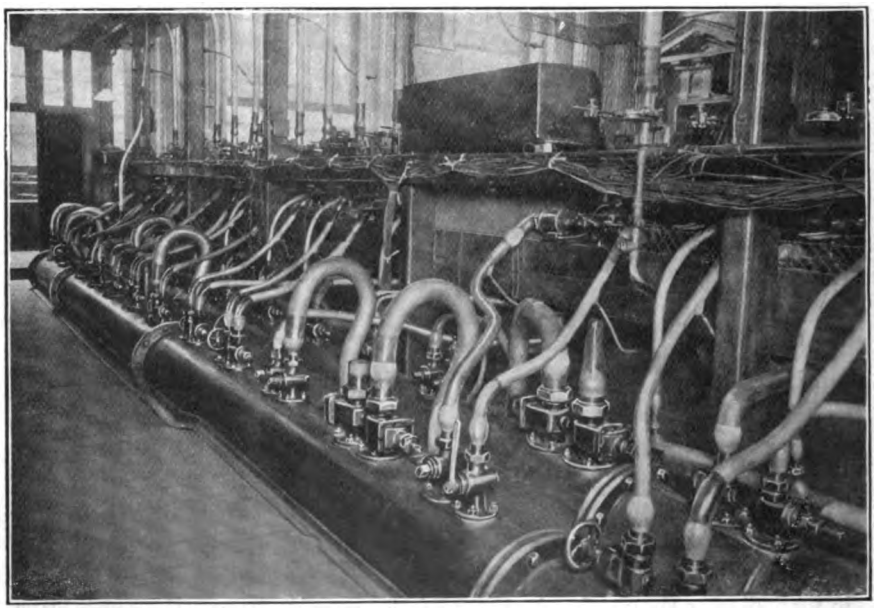
The speed of the carriers is approximately the same in both cases, and averages between twenty and thirty miles an hour in tubes not exceeding one mile in length. A $2\frac{1}{4}$ in. tube one mile long requires about five horse-power, and the transit time is two and a quarter minutes.

The cost of construction varies according to the nature of the ground. In London a single tube can be installed for about £2500 per mile, this amount including the cost of the lead tube, iron pipe, jointing, digging, and the reinstatement of the roadway or footway.

The engines for working the pumps in London are beam steam engines, working at 50 to 60 lb. to the sq. in., but high-pressure compound engines, electric motors and gas engines are employed in more modern stations. In order to neutralise the intermittent action of the pumps and to ensure a uniform flow of air, receivers or containers are provided in some cases; in others the air-mains between the air-pumps and tubes are made of large capacity. **3** is a



3

view at the rear of the Central Hall, St. Martin's-le-Grand, showing the two large mains which supply respectively the vacuum and pressure services.

There are two general methods of working pneumatic tube systems, namely, continuous running, in which the pressure or vacuum is applied to the tube continuously; and intermittent, *i.e.* when the tube is only connected with the air-mains during such

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times as the carriers are actually traversing them. For a given effective pressure carriers travel most rapidly under the intermittent system, and that is the arrangement adopted by the Post Office.

The tube attendants communicate with each other by means of signal bells of the block signalling type, the passage of a carrier being denoted by two strokes on the bell and its receipt by one stroke. The receiving boxes are, however, arranged so that the carrier itself on arrival depresses a bell contact and gives the necessary signal, and in the later form of apparatus the arrangements are being made still more automatic, the arrived carrier not only producing a signal, but also effecting the cutting-off of the power.

The longest tube working in this country is that between the Central Telegraph Office and the House of Commons, with the West Strand Office as an intermediate station. This tube, which is 3 in. in diameter, has a length of 3992 yards. It is worked in one direction only, and the average time of transit is $7\frac{3}{4}$ minutes.

Localising Stoppages.—If from any cause a stoppage occurs in the tube, carriers can almost always be drawn out by reversing the flow of air, but if this method fails it is necessary to open the ground at various points on the route and to cut open the tube until the stoppage is discovered. The position of the fault is roughly estimated by inserting a carrier and noting the time which elapses between its despatch and the instant at which it stops at the fault, as indicated by the cessation of the outgoing flow of air. The ground is opened and a longitudinal slot, $\frac{1}{2}$ in. wide by 3 in. long, cut into the lead tube; this allows a specially constructed slider to be inserted. After having been introduced sideways, the slider can be turned through an angle so as to fit the tube, and then, by means of a long steel wire, it is pushed along until the obstruction is reached, or until it can be pushed no further. In the latter case it is necessary to withdraw and reopen at another place. After the removal of the stoppage the slot in the tube is closed by a piece of sheet lead soldered over the opening.

Localising Leakages.—In order to localise a leakage the tube is opened out and cut, as in the case just described. A special stopper is then inserted which tightly closes the tube. At the engine end of the tube another stopper, which is connected to a pressure or vacuum gauge, is similarly inserted. The pressure or vacuum is turned on, and when the gauge is steady the tap is turned off, and the indications of the gauge carefully noted. If it falls very slowly, then the leakage lies beyond the section between the two stoppers, in which case the stopper is withdrawn from the slot, which is closed in the usual way, and the tests repeated until the faulty section is passed, which is indicated by the rapid fall of the gauge indication. It is, however,

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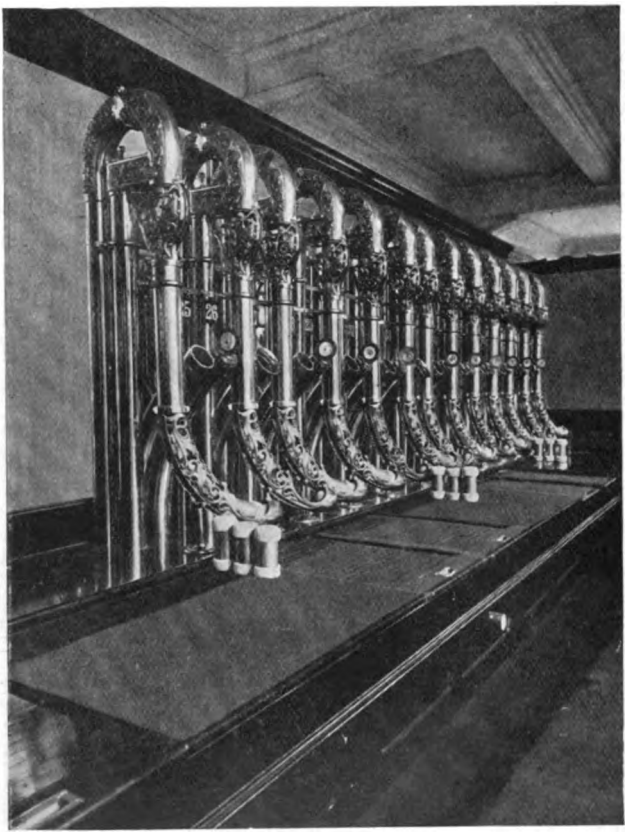
most frequently found possible to obtain information as to the position of a leakage by making a similar test in connection with the iron pipe and without cutting into the lead tube. For this purpose the ground is opened at a point where there is a sliding pipe, and the slide driven back so as to lay bare the lead tube. The space between the lead tube and iron pipe is then filled with clay all round. A small hole is pierced through the clay with a piece of wire. Now, if



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pressure is applied to the tube and the leakage is included in the section between the power end and the clay, the escaping air will charge the iron pipe and the leakage will become visible at the hole, and may be tested by holding a piece of lighted yarn to it, or by smearing the hole with soapy water.

In addition to the tubes provided solely for its own use, the Post Office has provided tubes connecting telegraph offices with the offices of the principal newspapers in most of the large towns, and so

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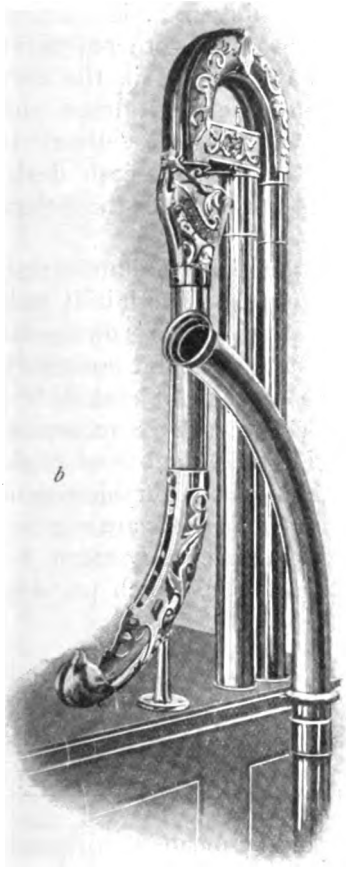
expeditious is the service as compared with a juvenile uniformed Mercury that no up-to-date newspaper can afford to be without it.

The total length of pneumatic tubes possessed by the Post Office is: House tubes, 11 miles; street tubes, 74 miles; total 85 miles.

Cash Tubes in Stores.—The pneumatic tube service has of late been making tremendous strides in quite another direction. All the principal stores and mercantile establishments now find a pneumatic tube service an indispensable item in their equipment.



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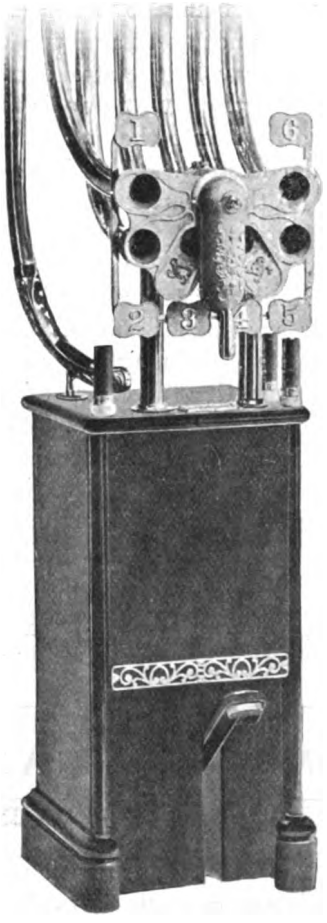

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In an out-of-date store, a customer either pays his money at the counter, and has to wait until the cash girl is called—goes to the cash desk and returns with his change—or else he is given a ticket and instructed to proceed to the cash desk and obtain a receipt for his payment before receiving his purchase. Neither of these processes is expeditious; the last mentioned is frequently objected to by

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the customer on the ground that he is not a messenger for the salesman, and both are inferior in every respect to the modern system, by means of which all cash transactions are centralised at one point remote from the sale-rooms, but connected with every salesman by means of pneumatic tubes, which enable change to be given together with receipts in a maximum time of six seconds. The same general principles of construction are applied here as in the Post Office system, but the continuous running method is invariably used, this being so because, the tubes being short, the cost of the service is not great and the continuous running method renders it unnecessary for the attendants to turn any valves or other apparatus. All that they have to do is to insert the cash or bills in the carrier and drop it into the end of the tube. On its return it drops out in similar fashion. This is shown in **5**, where (*a*) is the delivery tube and (*b*) the return tube. A good view of one side of a cash desk by means of which five cashiers attend to the work of forty-three departments is shown in **4**.

Similar systems have been adopted, principally by hotels, restaurants, newspaper offices, and stock exchanges. The initial cost is fairly high, and may be £40 or £50 per station. This is owing to the fact that the tubes are of brass and that the general construction work is kept to a high standard. The subsequent cost of maintenance is, however, exceedingly small, and it will be remembered that the tubes invariably displace a considerable number of cashiers and cash carriers, while they also bring about a considerable economy in the salesmen's time. Where smaller establishments are concerned foot-power tubes can be installed, and **6** illustrates a Lamson Foot-power Pneumatic Cabinet and Air Compressor, which provides a service for three out-stations.

SOME NOTES ON A METHOD OF AIR-PUMPING.

By E. W. Rees, Wh.Ex., A.R.C.S.

Post Office pneumatic tubes are worked by means of air-pressure varying from 10 lb. to 15 lb. per sq. in. for the down service, and as good a vacuum as can be economically maintained for the up service, 7 lb. to 10 lb. per sq. in. below atmospheric pressure being the general range.

In most cases separate pumps are used for the two services, but from the following considerations it would appear that more economical results could, in general, be obtained were a single pump used for both services, *i. e.* for pumping through from the vacuum-container into the pressure-container.

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For equal services in each direction it is necessary to instal pumps of about twice the displacement for the up service as for the down service, owing to the greater volume of air at the lower pressure at which it is drawn into the pump. Inasmuch as the work done in a pump is proportional to the cube of its linear dimensions, while the losses are more nearly proportional to the first or second

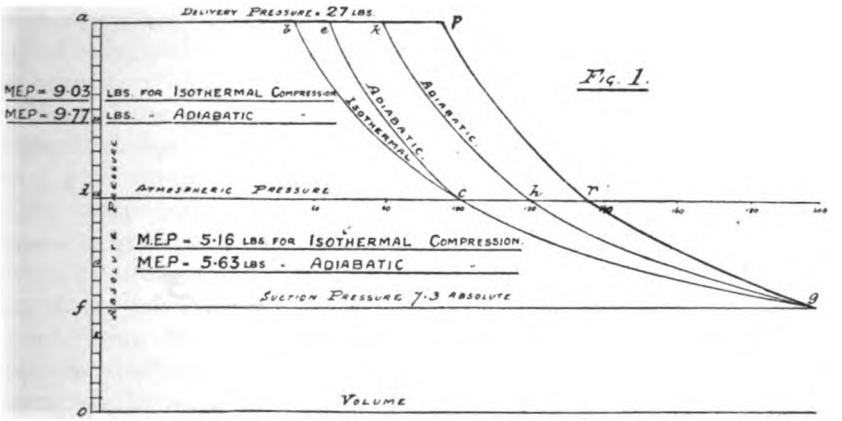

Fig. 1.

power of these dimensions, it follows that the larger the pump the higher the efficiency.

The losses due to the valves and pipe-work are of much greater importance in low-pressure pumping than in high-pressure pumping. It is, therefore, very desirable in pumps used for the Post Office pneumatic service to reduce these losses to a minimum.

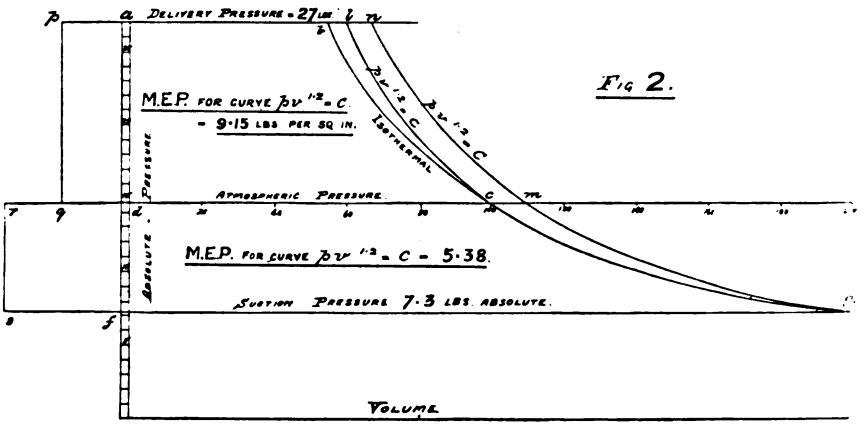
DELIVERY PRESSURE = 27 LBS.
M.E.P. FOR CURVE $pv^{1·2} = C$ = 9·15 LBS PER SQ IN.
$pv^{1·2} = C$
ISOTHERMAL
$pv^{1·2} = C$
ATMOSPHERIC PRESSURE
M.E.P. FOR CURVE $pv^{1·3} = C$ = 5·38
SUCTION PRESSURE 7·3 LBS. ABSOLUTE.
VOLUME

Fig. 2.

In 1 *a b c d* represents the work done in an air-pump compressing isothermally from atmospheric pressure to a pressure of 27 lb. per sq. in. absolute, while *a e c d* represents the same work performed adiabatically.

Similarly *d c g f* represents the work done by a pump drawing from a vacuum of 7·3 lb. absolute and delivering at atmospheric

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pressure, the compression taking place under isothermal conditions, while *d h g f* represents the work done in a similar operation performed under adiabatic conditions.

Isothermal and adiabatic conditions are, of course, limiting valves

Auxiliary Air Suction Valve.

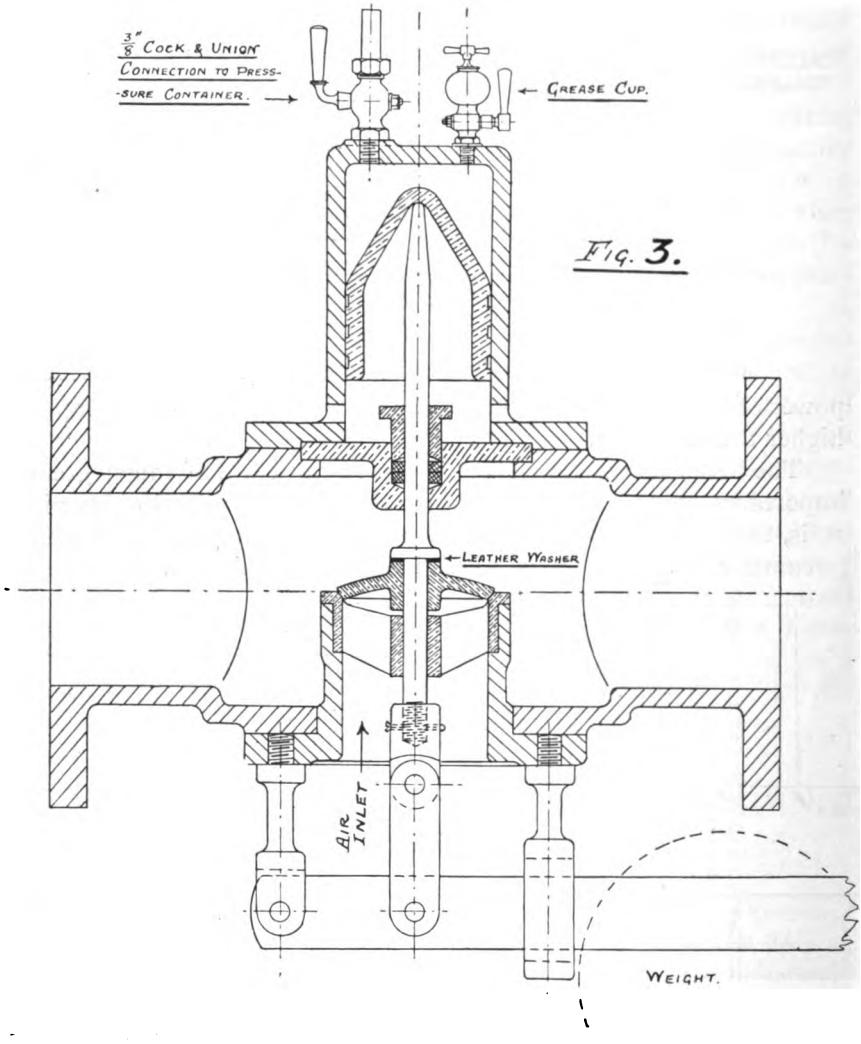

Fig. 3.

in reciprocating pumps, though the higher limit is greatly exceeded in turbo-compressors. The curve *g r p* in 1 is the equivalent compression in a case cited by one maker for an unjacketed turbo-compressor. It is found that in well-jacketed slow-speed machines the compression takes place according to the law, $p\, v^{1\cdot 2} =$

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constant where p and v stand for pressure and volume respectively. In **2** *a b g f* is reproduced from **1**, and represents the ideal isothermal compression to be aimed at; *a l c d* is a compression diagram from a pressure-pump according to the above law and between the same pressure limits, while *d m g f* represents the similar operation in a vacuum-pump. The triangular areas *b l c* and *c m g* represent the work lost in the pressure- and vacuum-pumps respectively, which, of course, becomes apparent as heat in the air discharged.

Now, if the pressure-pump were removed and the vacuum-pump arranged to discharge at 27 lb. per sq. in. absolute, the compression along *g m* would be continued to *n*, the total work done in the single pump being represented by the area *a n g f*, which, for the same weight of air discharged, exceeds the work done in two separate pumps by the work represented by the area *l n m c*, and at first sight this excess would appear to condemn the method. However, further consideration leads to a different conclusion. If we assume a mechanical efficiency of 80 per cent. for each pump, the area *p l c q* represents the work done by the prime mover in driving the pressure-pump, *p a d q* standing for various friction losses in this pump and prime mover. In the same way *r m g s* represents the work done by the prime mover in driving the vacuum-pump, *r d f s* representing the various friction losses. Now, if a single pump were used, the latter losses are not materially increased by the higher delivery pressure, while the lost work *p a d q* is entirely eliminated. Further, if the pressure in the pump exceeds the pressure in the suction-pipe and the delivery-pipe by 12 oz. per sq. in.—a usual value—then the loss represented by the product of this pressure into the volume *r m* is eliminated on account of the absence of atmospheric delivery valves, so also is the loss represented by the product of 12 oz. into the volume *c q*, owing to there being no atmospheric suction-valves. Measurements taken from the diagram show that these losses have the following values referred to the useful work in two separate pumps.

Economy due to power saved to overcome friction of a separate pressure-pump represented by *p a d q* . . .	= 11·4	per cent.
Economy due to absence of vacuum-pump delivery valves and pressure-pump suction valves	= 9·5	,,
Total . .	20·9	,,
Loss due to pumping between greater limits of pressure in a single pump . .	5·2	,,
Net saving . .	15·7	,,

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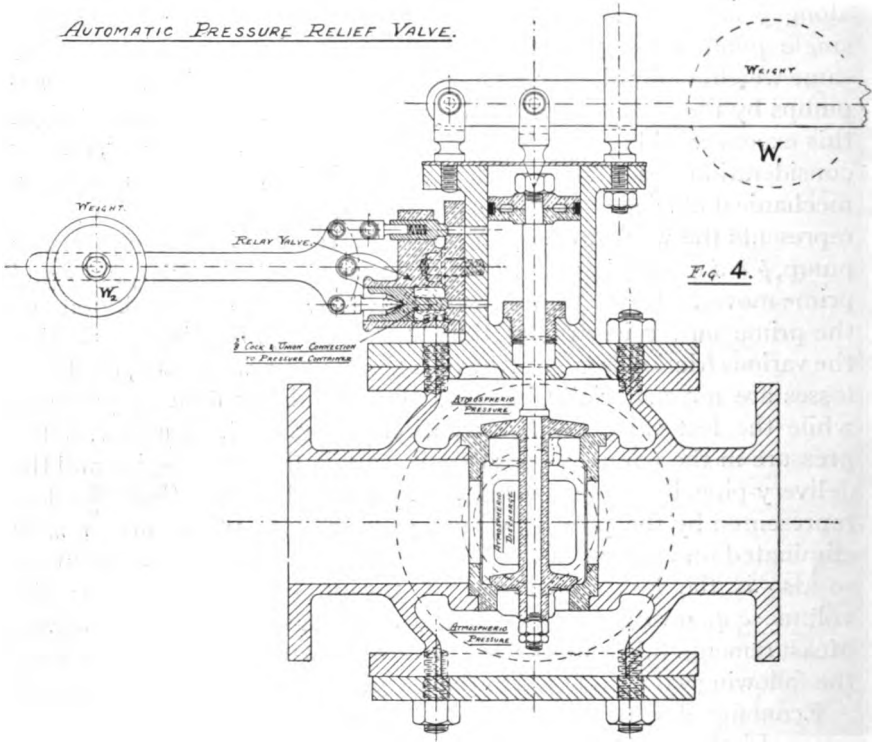
In an ideal pumping station there would be: (1) a single cylinder suitable for automatically providing either the vacuum or pressure service as may be required, (2) the compression would be carried out under isothermal conditions; (3) the pump would be elastic and automatically adjust its volume so that it is always proportional to the work it is called upon to do.

The first condition cannot be realised owing to the necessity for providing reasonable standby plant to meet breakdowns and periodical repairs, but these requirements are reduced to a minimum if all the pumps are of exactly the same pattern, when a single spare set will



meet all probable demands. These conditions are evidently met by such a system as is described above, so that the capital cost of the plant is reduced approximately 40 per cent. in virtue of the elimination of the pressure-pump and the reduced standby plant. The cost of buildings to house the plant is also reduced. The second condition cannot be obtained in practice, but it is approached as closely as possible by providing efficient water-jackets to the barrels and covers of the pumps. The third condition may be provided for by means of the automatic valves shown in 3 and 4. together with ordinary non-return valves opening in the normal

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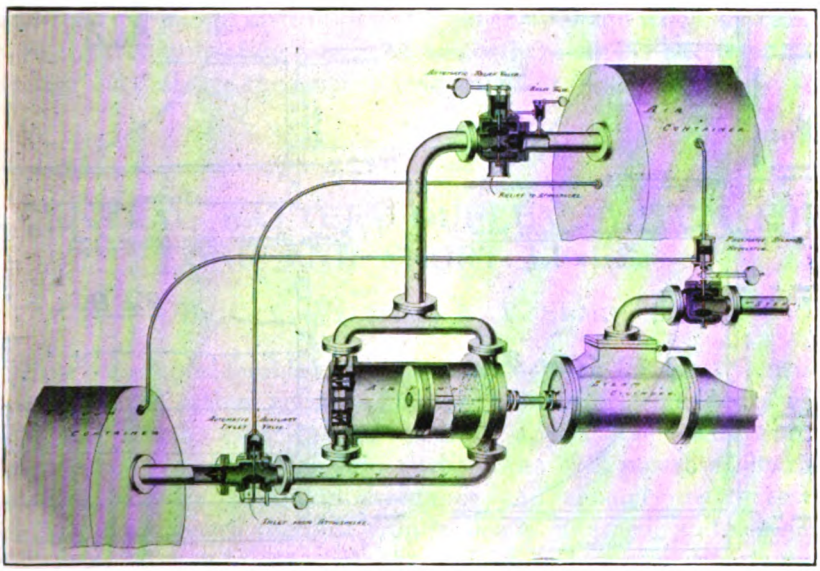
direction of the air-flow fitted between the automatic valves and the pressure and vacuum containers respectively. These valves effect an economy which may be as much as 50 per cent. of the total daily work done, but varies with the nature of the up and down services.

The automatic air-inlet valve shown in **3** is inserted in the common suction to all the pumps, and as near to them as may be. The valve is loaded by means of a piston working in a cylinder; the upper side of the piston is in constant communication with the pressure-container, the lower side is in communication with the air. The areas of the valves and piston are so proportioned that when the desired pressure is reached the valve closes, and all the pumps which may be running work on vacuum. If the vacuum is so high



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that the pressure is not maintained in the pressure-container the air-inlet valve opens, admitting sufficient air to the pumps to make up the pressure; at the same time the non-return valve closes, cutting off the vacuum-container and mains, maintaining the high vacuum already pumped therein.

4 shows a section through an automatic pressure relief valve. It consists of a double-beat valve opening to air, and is inserted in the common delivery from all the pumps, and as close to them as possible. The valve is controlled by means of a piston working in a cylinder, the lower end of which is put into communication with the pressure-container by means of a small relay valve. If the air-pressure in the relay valve cylinder, which is always in communication with the pressure-container, reaches the desired value, the relay

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piston moves to the left, opening the port in the large cylinder to the pressure-container. The piston in the large cylinder is of such an area that it lifts the weight W, together with the valve very smartly, thus putting the discharge of all the pumps directly to the atmosphere, and throwing off the whole of the pressure load. At the same time the non-return valve closes and cuts off the pressure-container and mains, maintaining the high pressure already pumped therein. If the pressure in the container falls slightly the weight W_2 causes the relay piston to move to the right, closing the lower port of the controlling cylinder, and allows the air to escape through the upper port, when the double-beat valve closes, and all the pumps again take up the pressure load.

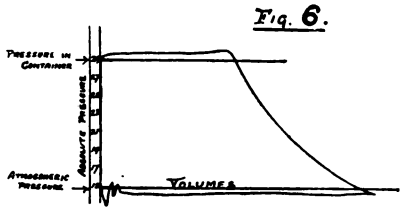

Fig. 6.

Normal Diagram from Pressure Pump.

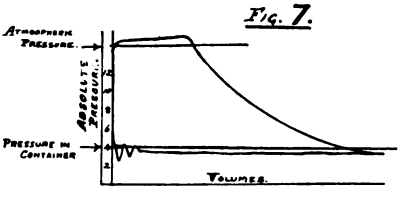

Fig. 7.

Normal Diagram from Vacuum Pump.

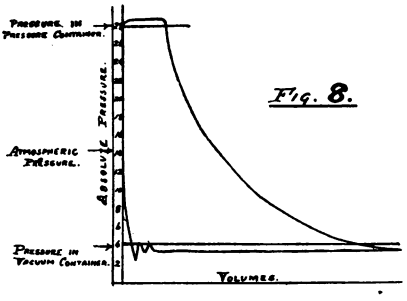

Fig. 8.

Normal diagram from Pump working through on a balanced load.

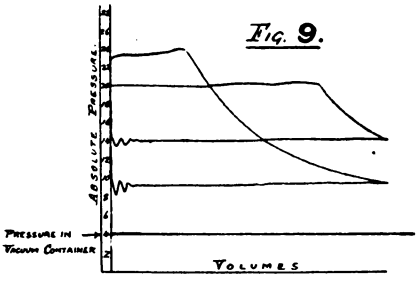

Fig. 9.

Diagram obtained when Auxiliary A&R Suction Valve partially opens to make good slight reduction of Pressure. Shews air delivered to vary in accordance with the demand.

5 shows the arrangement of the valves, together with a method of controlling the prime mover (a steam engine in this case) adopted in a particular instance.

It will be seen, therefore, that up to the limit of the total volume of all the pumps installed the system is completely elastic, and automatically puts all the pumps to vacuum or to pressure, or partially to both, or slows down the prime mover, as may be required.

6 and 7 show normal diagrams obtained from separate pumps, while 8 and 9 show the effects of pumping through. It may be remarked incidentally that the method of pumping through causes the pump to work with a minimum of noise.

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It has been suggested that, considered as a pressure pumping system, the method of pumping through is inefficient, and more economical results would be obtained were a full charge of air admitted to the cylinder at the end of each suction stroke. However, careful consideration will show that the effect of such a provision on the prime mover would be very trying and lead to reduced efficiency, and it is altogether unnecessary, as the air-inlet valve allows a full charge of air at atmospheric pressure when called for, without throwing excessive load on the prime mover. A further objection may be raised to the effect that it is uneconomical to admit air into the suction main instead of into the pumps themselves. This is true, but the loss is of the order of a small fraction of 1 per cent., and it can only be avoided by employing two valves to each double-acting pump, instead of a single valve for the whole system.

Such a complication would be so costly to supply and maintain as to far overbalance the small saving aimed at.

A CENTRAL BATTERY DUPLEX SYSTEM FOR LONG AND SHORT LINES.

By C. C. VYLE and E. V. SMART.

FOR some considerable time the need has been felt for a Central Battery duplex system suitable for use on lines of from 20 to 150 miles in length. Such lines possess appreciable electrostatic capacity, may terminate in offices where the skill possessed by the operating staff in obtaining resistance and capacity balances is insufficient to ensure the best results being obtained, and, like all other lines of such lengths, may be subject to low insulation in wet weather. Many systems have been tried, but that herein described is one of the most efficient yet developed.

The skeleton diagram 1 illustrates the arrangement:

So far as the central station is concerned it will be observed that a key capable of reversing the direction of the current is provided, and that the current passes differentially through the coils of a non-polarised relay and a galvanometer respectively in such a way that if the one portion of the current be equal to the other no effect is produced on either instrument.

At the out station (*a*) the signalling key short-circuits a rheostat R, but on depression of the key the resistance in the rheostat is added to that of the line; (*b*) a polarised relay with sounder and battery in local circuit, or a polarised sounder alone direct in the line may be provided.

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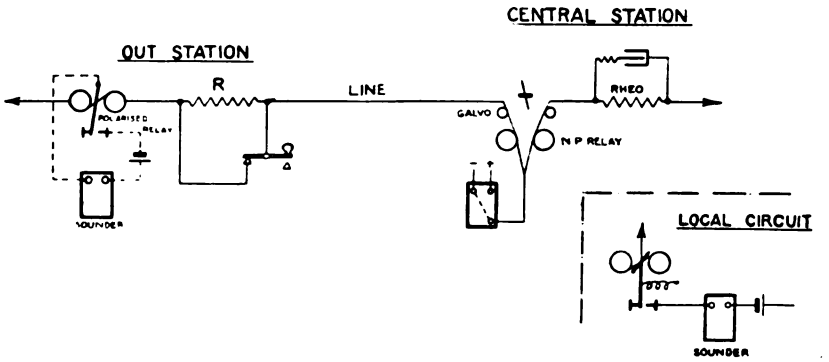
The central station operator first inserts sufficient resistance in the rheostat at that station to ensure that the majority, say 75 per cent., of the total current strength shall flow to line. Then the distant station is requested to depress the key and to increase or decrease the resistance in the rheostat at the far end until the galvanometer needle at the central station points to zero, *i.e.* until a resistance balance is obtained. Next, the central office balances for capacity (the out office key being still depressed), and puts sufficient tension on the relay tongue spring to bring the armature away from the pole pieces and cause the tongue to make decided contact with the stud on the right, thus completing the local circuit and registering a "mark." The amount of tension required on the spring to produce good signals is a matter of some importance. In practice it is found best to make it half that required to render the tongue "neutral" when the out station's key is up; or a mean



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between that required to render the tongue "neutral" in the two conditions—(*a*) distant key down and (*b*) distant key up.

It will thus be seen that the central office operates the polarised apparatus at the distant station by reversing the current, and that the out office operates the apparatus at the central station by equalising the strengths of the currents in the coils of the non-polarised relay so as to allow the spring to act and cause the tongue of the relay to complete the local sounder circuit.

The success of the system depends upon the adjustment of the antagonistic spring of the non-polarised relay, which has to be such that the tongue does not move over to the right-hand stud while the central station is sending, but does so when the out station's key is depressed, and the circuit becomes balanced so far as the central station is concerned. Between these two conditions there is a very wide margin.

The advantages claimed for the system are:

(1) No batteries are required at the out station if a polarised

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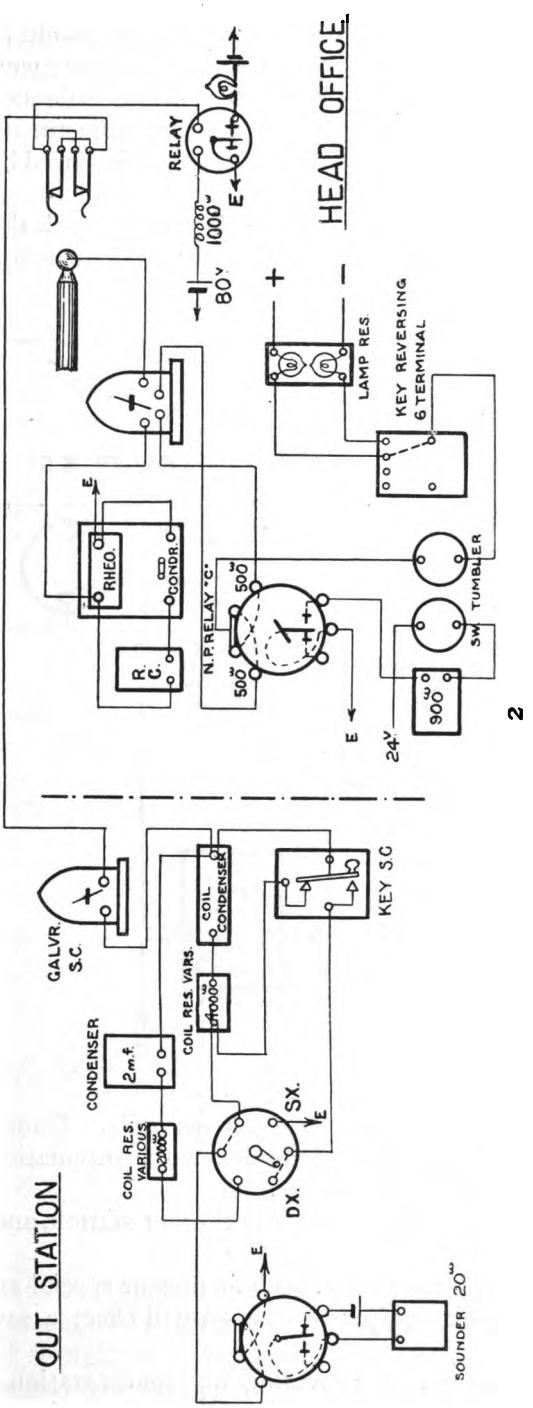

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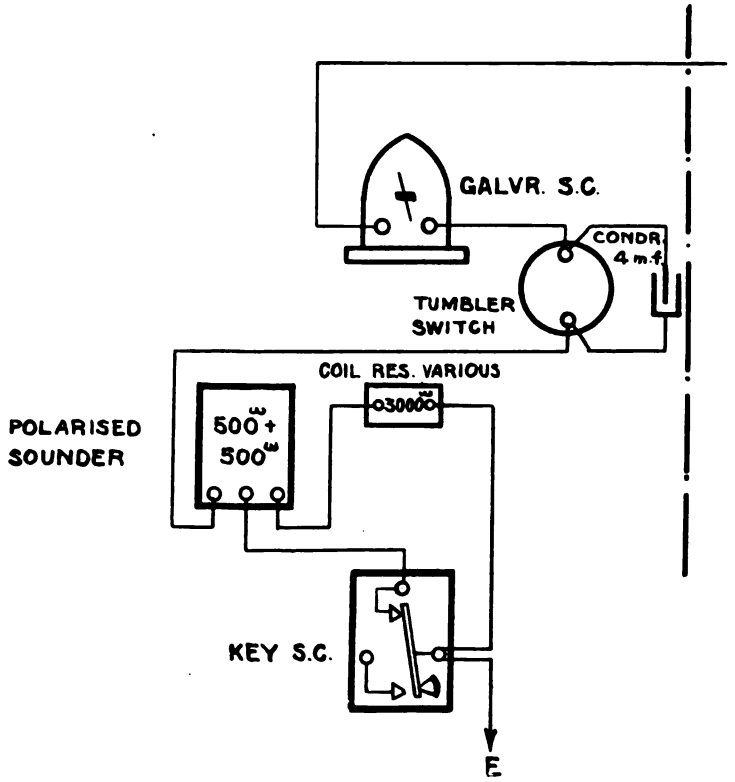
sounder is used, but on circuits subject to variation due to weather conditions a polarised relay with a local circuit should be used so as to ensure a constant volume of sound during duplex working.

(2) One office only—the head office—has to balance the circuit. The out station has no balances nor fine adjustments to make; only the resistance in the rheostat at that end is varied by instruction from the head office.

(3) The system is practically independent of leakage. It has worked on a wire of approximately sixty miles in length when the



3

insulation was down to 70,000 ohms per mile. Under these conditions the circuit was worked duplex with Automatic Wheatstone at about eighty words per minute.

(4) A great saving in apparatus at the out station, and no increase at the head office.

(5) In times of emergency, such as fires or special arrangements, the easy and quick equipment of a set will effect a saving in time and money.

2 shows a means of providing for concentration at the head office, and for calling the out station by condenser impulses.

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3 indicates the arrangement when a polarised sounder is used at the out station, a course which may be conveniently adopted when the circuit is of moderate length.

A STUDY OF RELAYS.

By A. C. Booth.

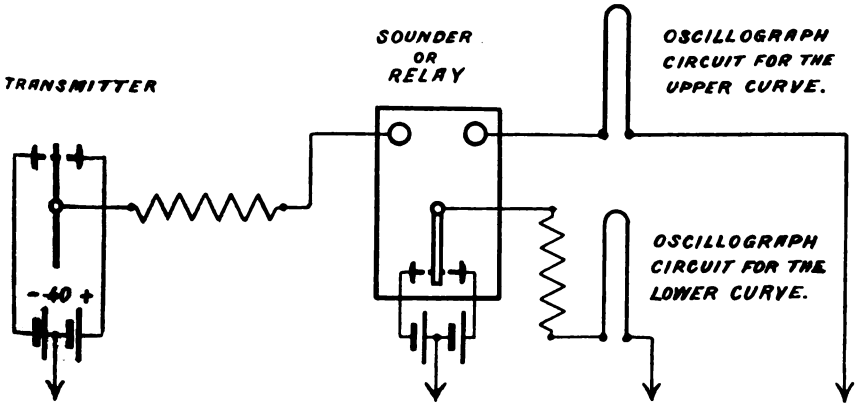
The accompanying oscillographs may prove useful to many readers who have not the opportunity, nor, perhaps, the time to make a practical study of the action and speed of relays.

The object of the experiments was to ascertain whether it was desirable, with a view to obtain a higher working speed, to undertake any improvement in the design of the Post Office standard relay. At the same time opportunity was taken to make a comparison with the P.O. sounder and with the Baudot relay.

The time constants of these instruments, *i.e.* the time taken in each case for a current to rise to ·632 of its maximum, are as follows:

P.O. sounder . . .	·016 seconds.
P.O. standard relay B .	·023 ,,
Baudot relay . . .	·0078 ,,

The diagram of the connections shows the path of the currents and the position of the oscillograph. Where only one transmitting or receiving voltage was employed the negative voltage was disconnected.



In each plate the upper curve shows the rise and fall of the transmitting current; the lower curve shows the repeated current, and the central straight line shows the zero point when a complex curve is taken or when one curve is superposed upon another, of which 6 is an example.

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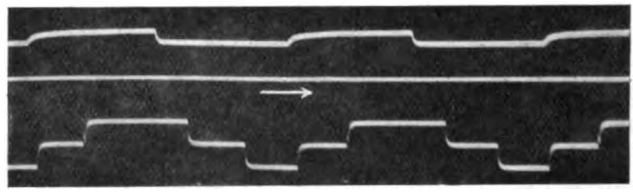
1 is taken from a sounder relay somewhat similar to those fitted on a type of repeater or translator in fairly large use by various countries for Hughes' simplex circuits. The zero line in the lower curve is the no-current position, and indicates the time occupied by the lever of the sounder in its passage from one contact to the other.

To obtain this comparatively high speed of sounder working a delicate adjustment was required, otherwise the lever did not have

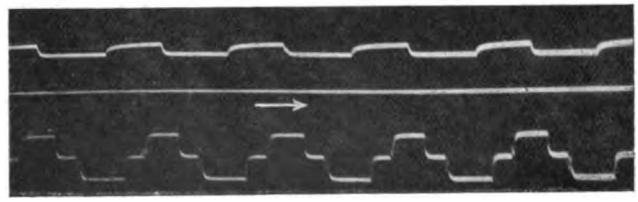


1.—SOUNDER RELAY (ordinary Post Office Sounder equipped as a Relay).

Resistance	= 900 ohms. (1000 in coils shunted by 10,000).	Repeated current	= 25 m.a. ±.
		Speed in words	= 70 per minute.
Inductance	= 14·4 henries.	Duration of signal	= ·0166 seconds.
Time constant	= ·016 seconds.	Rise of current	= ·0008 ,,
Transmitting voltage	= 40 +.	Lag of repeated signal	= ·0084 ,,
Working current	= 10 m.a. +.	Movement of lever	= ·007 ,,

time to traverse the space between the two contacts. With higher tension on the retractile spring the lever jarred on the contacts, producing broken signals. The jarring of the lever was not altogether cleared, and is indicated in the upward portions of curve B. This is clearly due to the pull of the magnet increasing as the lever descended, while the pull of the retractile spring descreased as the lever ascended.

2 shows the same sounder repeating at 140 words per minute,



2

necessitating an extremely delicate adjustment and increased tension on the retractile spring, with the result that the lever chattered slightly on both upper and lower contacts. The duration of the signal is ·00832 seconds, while the other particulars are the same as in 1.

3 shows the same sounder adjusted as in actual practice, and repeating at a speed of twenty-eight words per minute, which is equivalent to the signals given by the letters E J O T X, etc., on a Hughes instrument running at a speed of 120 revolutions per minute.

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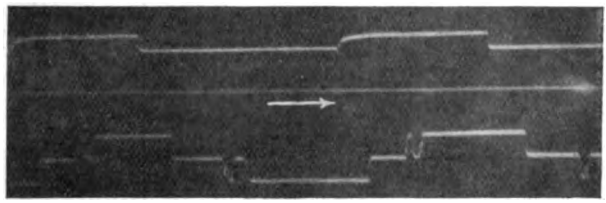
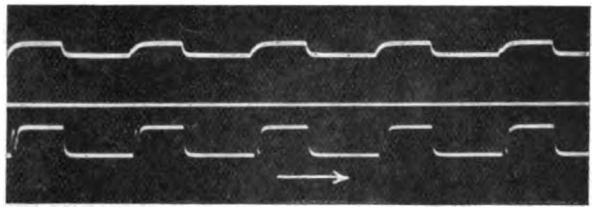
It will be observed that the lever rebounded from both contacts, giving an appreciable increase both in the time occupied by the



3.—Transmitting voltage = 40 +.
Working current = 13 m.a. +.
Repeated current = 25 m.a. ±.
Speed in words = 28 per minute.
Duration of current = ·0446 seconds.
Rise of current = ·0012 „
Lag of signal = ·0253 „
Movement of lever = ·0168 „

lever in descending and in the lag of the repeated signal. This rebounding, although not noticeable in Morse working, must have

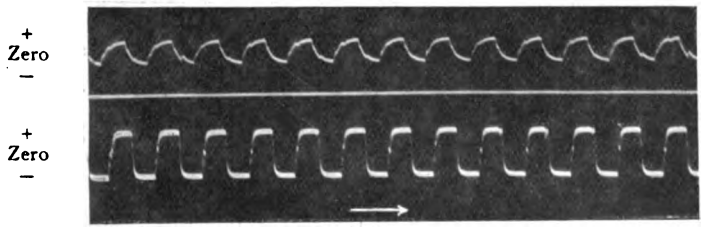


4.—Baudot Relay.

Resistance = 200 ohms.
Inductance = 1·56 henries.
Time constant = ·0078 seconds.
Transmitting voltage = 40 +.
Working current = 10 m.a. +.
Repeated current = 25 m.a. +.
Speed in words = 140 per minute.
Duration of signal = ·00832 seconds.
Rise of current = ·00086 „
Lag of signal = ·00172 „

a relatively considerable effect in Hughes' working, where the accurate timing of the repeated signal is of the highest importance.

4 shows the Baudot relay repeating at 140 words per minute after having been set as in ordinary working conditions, and then given a



5.—Baudot Relay.

Speed in words = 400 per minute.
Duration of signal = ·00312 seconds.
Rise of current = ·00081 „
Lag of signal = ·00108 seconds.
Movement of lever = ·00081 seconds.

spacing bias. The contacts were fairly closely set, but this did not prevent the momentum of the tongue producing a rebound.

The lag of the repeated signal B is almost negligible.

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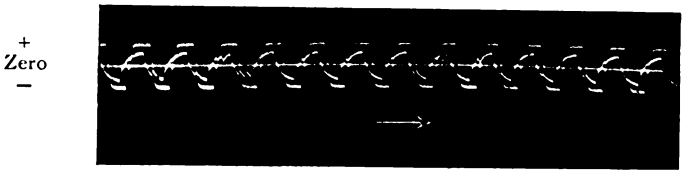
5 shows the Baudot relay repeating Wheatstone reversals at a speed of 400 words per minute. The upper curve shows the working current through the coils of the relay and the chattering of the transmitter lever on its contacts. This defect could not be entirely removed, but even when it was very much worse the repeated signals were quite satisfactory on a Wheatstone receiver.

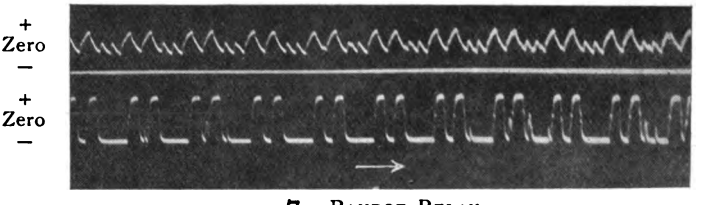
The repeated current is very regular, but shows an occasional break near the end of the positive signal. The reason for this is not



6.—Baudot Relay.

quite clear, but it may have been due to a momentary short-circuiting of the two contacts by the tongue, as the setting of the contacts was very close indeed. Some difficulty was experienced in effectually clearing the jarring of the tongue on the contacts.

6 is practically identical with 5, but the transmitted and received signals have been superposed to more clearly indicate the lag. The transmitter contact is broken in several instances, but the repeated signals are correct in every case, and do not show the occasional break as in 5, although the speed in this case is 429 words per minute.



7.—Baudot Relay.

Transmitting voltage	= 40 ±.	Rise of current	= ·0008 seconds.
Working current	= 13 m.a. ±.	Lag of signal	= ·00083 ,,
Repeated current	= 25 m.a. ±.	Movement of lever	= ·00037 ,,
Speed in words	= 1080 per minute.		

7 is an extremely interesting case, it being believed to be the first record of a relay repeating at such a high speed.

The transmitting signals were obtained from a multiplex distributor, having a number of segments to which a connection was made by means of a travelling brush fixed to an arm rotating at a fairly high speed.

The segments of the distributor were separated from each other by a neutral segment of about one fourth the width of a live segment. The voltage to the segments was arranged as follows:

+, —, +, —, —, —, etc.,

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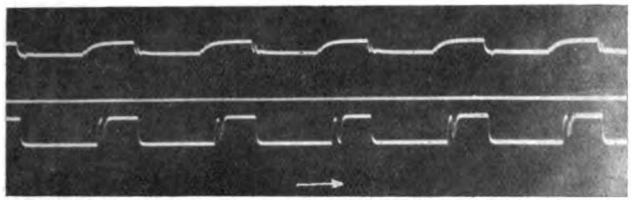
in order to give a dot and dash series of signals to prevent any assistance being obtained by the rebounding of the tongue, which might have occurred when reversals only were being signalled.

The breakage in the repeated signals occurred at the moment when no current was passing through the coils of the relay, that is to say, whan the brush was on the neutral separating segment, thus



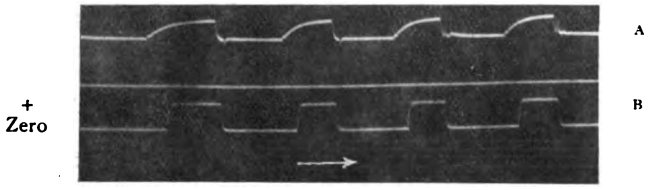
8.—Post Office Standard Relay B.

Resistance	= 200 ohms.	Speed in words	= 140 per minute.
Inductance	= 4·6 henries.	Duration of signal	= ·00784 seconds.
Time-constant	= ·023 seconds.	Rise of current	= ·00181 ,,
Transmitting voltage	= 40 +.	Lag of signal	= ·00332 ,,
Working current	= 10 m a. +.	Movement of lever not shown in this plate.	
Repeated current	= 25 m.a. +.		

indicating a slight want of neutrality in the setting of the relay contacts, which were exceedingly close.

The speed obtained was not the limit, and is very much higher than the maximum working requirement.

8 shows a Standard B Post Office relay working at 140 words per minute. Although the contacts were set fairly closely the tongue rebounded, as in the Baudot relay (4). It will be observed that, owing to the higher inductance, the rise of current in the coils is slower than in the Baudot relay.



9.—Post Office Standard Relay B.

9 shows the same relay working at the same speed, but with improved setting there is no chattering of the relay tongue.

10 shows the Post Office relay repeating at 400 words per minute, and is comparable with 5 and 6 regarding the Baudot relay. In this case the transmitter lever was giving less chattering at its contacts, and a galvanometer had been placed in the repeated circuit, thus slowing the rise of the repeated current.

11 shows the Post Office relay repeating at 1080 words per

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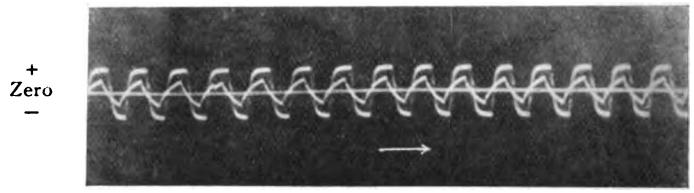
minute, and is comparable with 7, in which the Baudot relay is doing the same. The slower rise of the repeated current in this case is due to the coils of a galvanometer in the repeated circuit.

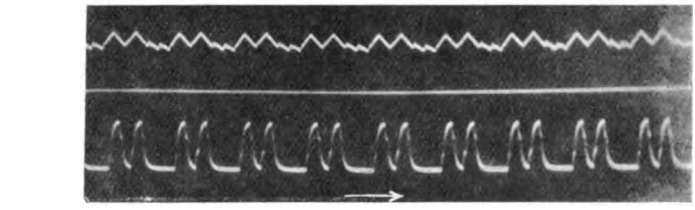


10.—Post Office Standard Relay B.

Transmitting voltage	= 40 ±.	Duration of signal	= ·0031 seconds.
Working current	= 13 m.a. ±.	Rise of current	= ·00187 ,,
Repeated current	= 25 m.a. ±.	Lag of signal	= ·00125 ,,
Speed in words	= 400 per minute.	Movement of lever	= ·00125 ,,

The transmitting arrangement used was the multiplex distributor, with contacts arranged as already described in reference to 7. The highest available speed with this device was 1080 words per minute.

The foregoing oscillographs indicate that no improvement in the design of the Post Office standard relay is at present necessary for the purpose of obtaining a higher speed. The speed of 1080 words per minute, although not the maximum obtainable with the relay, is



11.—Post Office Standard Relay B.

Transmitting voltage	= 40 ±.	Duration of signal	= ·00116 seconds.
Working current	= 13 m.a. ±.	Rise of current	= ·0081 ,,
Repeated current	= 25 m.a. ±.	Lag of signal	= ·00084 ,,
Speed in words	= 1080 per minute.	Movement of lever	= ·00063 ,,

very much higher than the maximum speed of the Wheatstone receiver, which in practice is about 400 words per minute.

The use of a Sounder type of relay, although practicable, is much less satisfactory, and it should not be used on circuits where any type of machine telegraph is employed.

As regards facilities for adjusting and cleaning the relays, it was found that the somewhat elaborate arrangement of the Baudot relay was no more effective than the simpler arrangement in the Post Office relay, and that for purposes of regulating the relays the single screw of the Post Office was very much more convenient than the four screws of the Baudot.

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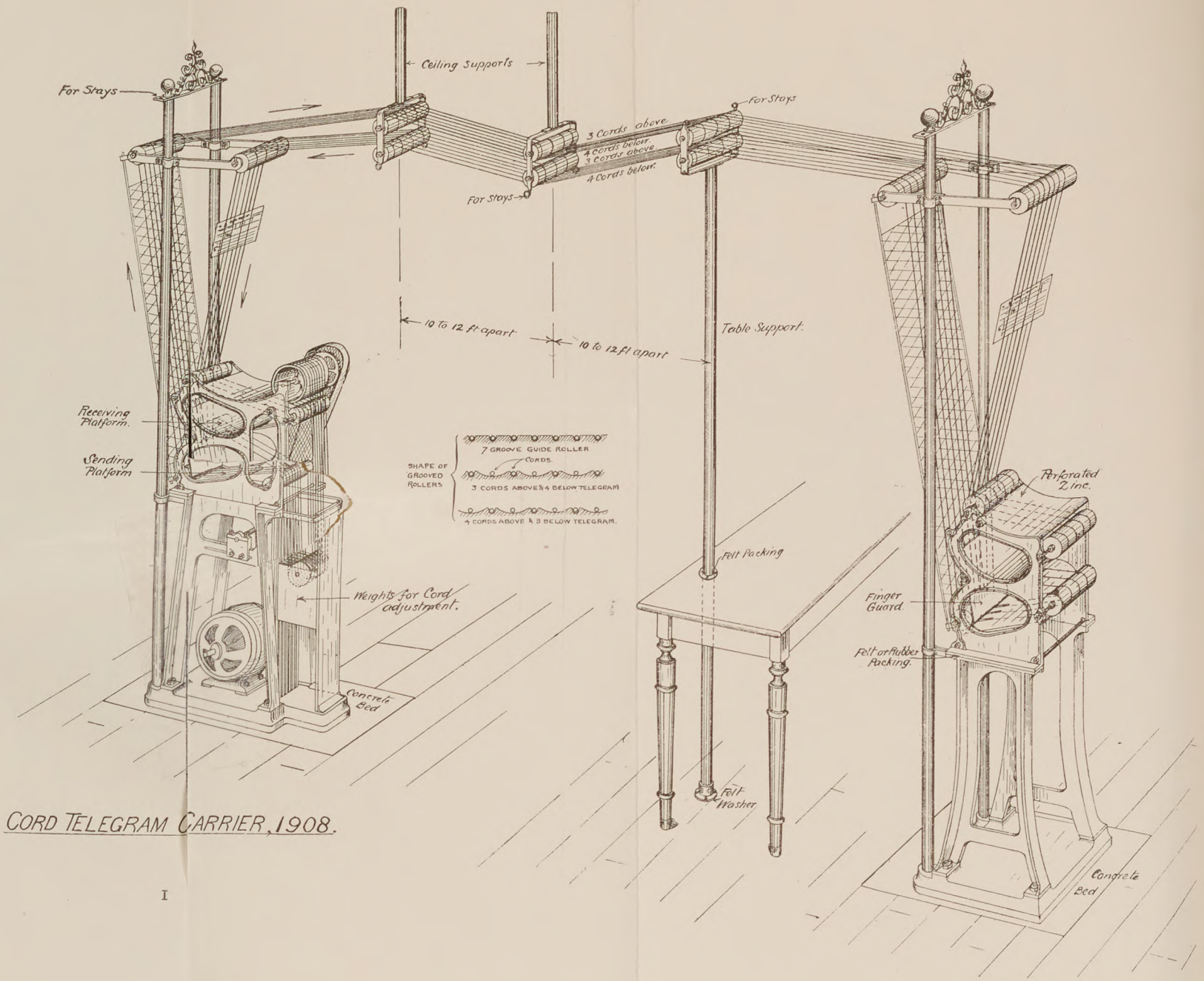

CORD TELEGRAM CARRIER, 1908.

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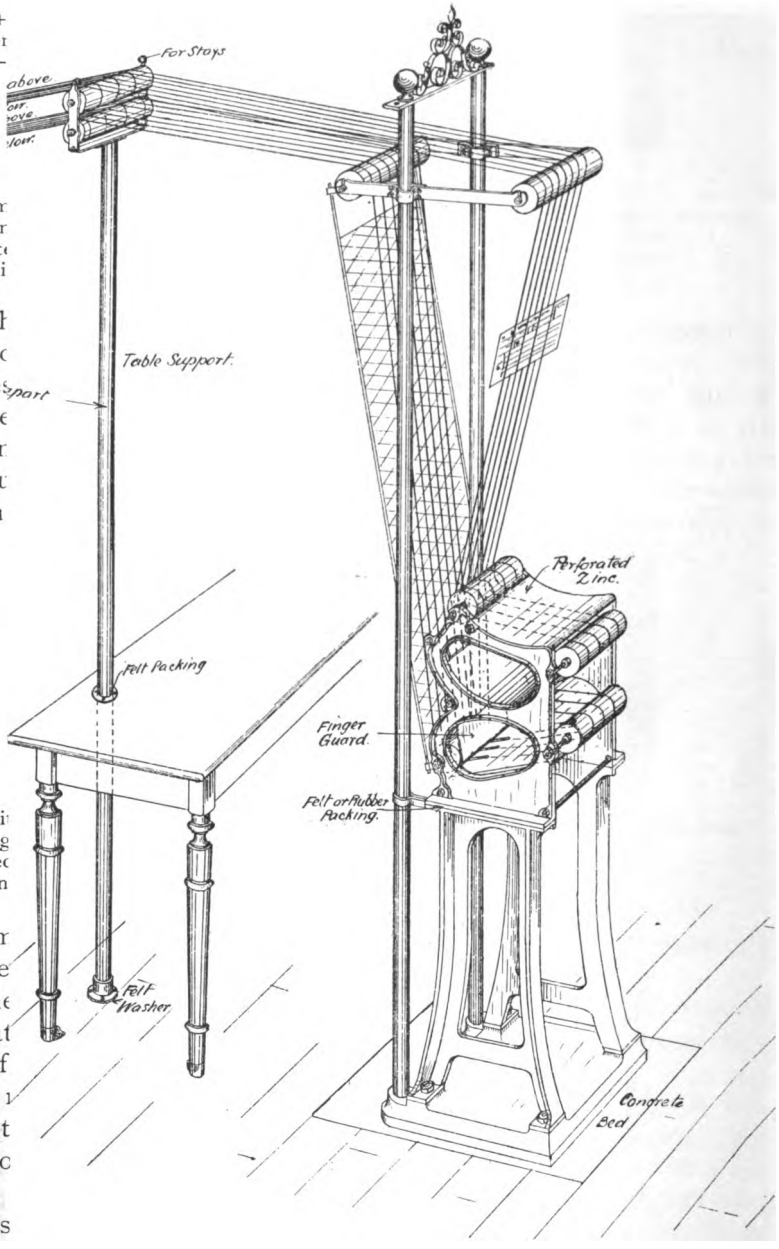

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THE MACHINERY OF THE POST OFFICE.

By H. A. Miles.

To the lay mind my title is pregnant with a meaning symbolical of all that is considered worst in officialdom, the need for precedents, slavish adherence to rules and regulations, in fact, all those necessary methods of procedure comprised under what is officially known as "system," but nicknamed "red tape" by the uninitiated. In this case, however, the meaning is to be taken literally, and in the two or three short articles, of which this is the first, I propose to describe those appliances which, owing to their mechanical character, have not come within the scope of the various works on telegraphy and telephony. The pneumatic perforator, for instance, was for the first time fully described by the writer in the 'Telegraph Chronicle' of October 15th, 1897. Cord carriers, band carriers, postal conveyors and mail-bag cleaners are other such nondescript contrivances which are nevertheless of interest to engineers and others who do not happen to be within reach of offices at which they are employed.

The present article will deal with telegram and telephone carriers, which have come so much to the front in the larger offices during recent years, and about which inquiries are not infrequently made by Foreign Administrations.

The cord carrier (1) consists of appliances by means of which two series of endless cords are kept running between two points at the necessary distance apart. These cords are arranged alternately, so that the messages are interlaced between them.

The cords are made to travel around a driving drum (actuated through counter-shafting by an electric motor) and certain pulleys at one end of the route, then alternately over and under other guiding pulleys at as many intermediate points as may be necessary, around certain pulleys at the further end of the route and back to the starting-point, any stretching being compensated for by means of sliding pulley weights. The terminal machines are each so arranged that the cord series are separated at one point in order that message forms may be inserted between them for transit to the distant end, and at another point so that forms arriving may fall from between them on to the receiving platform. The manner in which this is accomplished will be seen from 2, which shows in diagram form the present arrangement of the cords from end to end of the route, the direction in which the cords are travelling being indicated by arrow-heads, and the number of cords on either side of the message form by the numerals.

The speed in transit is not great, but as there is practically no

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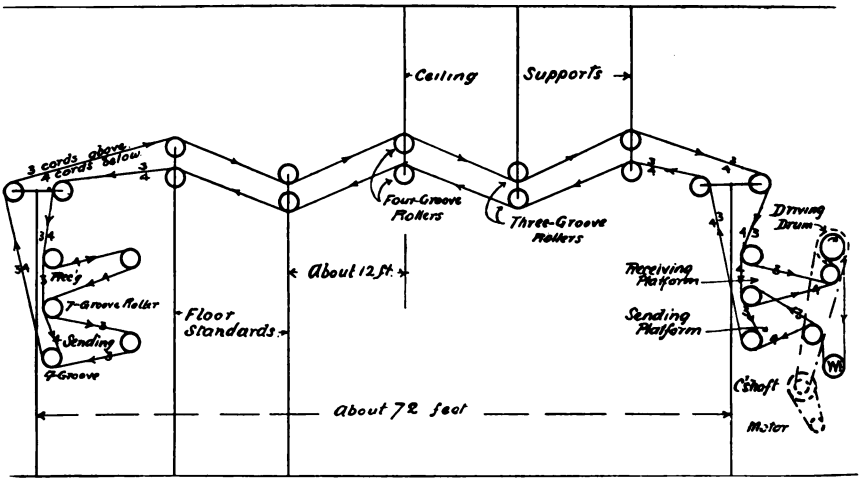
initial or final delay, such as occurs with the pneumatic system, the time occupied between the circulation tables is considerably less than in the case of tubes, while there is also the great advantage that the traffic is in sight during the whole journey and instantly accessible in the event of a temporary stoppage.

The cord telegram carrier in its present form was invented by David Reid, of the Engineering Department, though unknown to him a tape carrier on very similar lines and driven by steam power had been in existence in 1871 (3). After much unprofitable experimenting at his own expense, Mr. Reid at length obtained a small grant in order that a trial carrier might be made. This was the appliance constructed from various oddments of wood and metal which was erected at Glasgow in 1896 and for some time adorned the office.


Ceiling
Supports
3 cords above
4 cords below
3/4
Four-Groove Rollers
Three-Groove Rollers
Driving Drum
3/4
3/4
3/4

The inspection led to the discovery of a few weak points, among which were (*a*) the frequent breakage of the round leather driving-belts, (*b*) the fact that five cords were insufficient to ensure the safe transit of small forms such as Service messages, etc., and (*c*) the warping of the wooden rollers. Cycle-chain gearing to replace the leather belt was suggested but not at once adopted, and the second difficulty was overcome by the use of seven cords instead of five.

After approval the first carrier was delivered at Manchester, in April, 1903, the second was sent to the Central Telegraph Office, and the third and fourth to Manchester, Birmingham taking two of the remaining three at later dates.

Each of these carriers was considerably modified after erection.

3.—Tape Carrier (1871) Reproduced, by Permission, from 'The Graphic.'

Chain-gearing was fitted locally in each case. Vibration and noise were deadened by insulating the parts from the tables by rubber or felt and the steel tubular standards were filled with sand.

A considerably improved design had meanwhile been prepared in which the use of the instrument table as a support was entirely dispensed with, being replaced by a cast iron frame and bed-plate, the latter bolted to a concrete foundation, the adoption of intermediate supports suspended from the ceiling whenever possible, the introduction of aluminium rollers filled with paraffin wax and an improved form of ball-bearing brought noise and vibration almost to a minimum. These self-contained carriers have been erected at London, Glasgow, Liverpool and Leeds, and are giving full satisfaction.

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To further improve the running the chain gear was subsequently replaced by a flat belt drive, and a carrier so fitted was erected between the Telephone-Telegram Room and the Central Hall at the C.T.O., and has been acknowledged as practically perfect. There is, however, one drawback: the cords are blackened by the aluminium rollers and slightly impair the legibility of the messages unless the forms are folded face inwards; there is, however, every probability of the defect being removed in the near future by the substitution of a more suitable material for the rollers. An important item is the cord, which necessitates a peculiar combination of tensile strength, flexibility and durability.

Numerous varieties of cord made of hemp, flax, and other materials have been tried with widely varying results, some of the strongest varieties fraying out and disintegrating so rapidly as to be quite useless.

Nothing has been found to meet requirements better than Peacock's cable cord, a cable-laid cotton cord which lends itself readily to splicing, does not fray out in use and is fairly strong and durable.

The amount of wear and tear in these machines is very considerable, and in order that it may be appreciated and proper care be devoted to cleanliness and lubrication it may be pointed out that the cords travel at an average speed of about four miles per hour, and in the course of a year each cord covers a distance of nearly 14,000 miles, while during the same time the grooved guiding pulleys have each revolved over 111,000,000 times, and the steel balls in the bearings about 333,000,000 times.

The progress of the carrier is shown in the following summary:

1870.—Tape carrier in use by E.T. Co. at Telegraph Street when taken over by the Government.

1896.—First cord carrier erected at Glasgow.

1901.—Carrier erected at Edinburgh.

March, 1903.—New and more rigid design prepared and six carriers ordered.

May, 1903.—Arranged for seven cords instead of five.

May, 1903.—Cycle chain instead of round belt suggested.

February, 1904.—"Long splice" for cords introduced after trial.

February, 1904.—Reversed separating combs—working much improved.

July, 1904.—Cycle chain drive introduced in place of round leather belt.

November, 1904.—Angular route carrier (three right angles) first successfully run at C.T.O.

August, 1905.—"Switchback" arrangement introduced, nearly

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halving the number of rollers required and much reducing energy necessary for drivers :—

Birmingham saved 20 rollers. Current reduced from 350 to 250 Watts

Manchester { „ 16 „ „ „ „ 200 „ 140 „
„ 14 „ „ „ „ 190 „ 140 „

March, 1906.—Two-inch wooden rollers replaced by three-inch aluminium, and frame re-designed to stand on concrete bed quite independent of tables.

August, 1907.—Aluminium rollers filled with paraffin wax and flat belt replaced chain gear. Carrier pronounced perfect when erected.

Up to the present time fifteen cord carriers have been erected at Birmingham, Edinburgh, Glasgow, Leeds, Liverpool, London, and Manchester respectively; three more are now being constructed, and four others are contemplated in the near future. Instead of installing pneumatic tubes as a means of communication between the public counter and instrument room, when both are on the same floor, the trial of a simple spring and trigger device made by the Lamson Store Service Co. was suggested by the writer for the Chancery Lane B.O. It has now been in use for ten months and has proved quite satisfactory over a route of about thirty feet, including an angle. Another B. O. shortly to be opened will be similarly fitted. Another form of message conveyer is the band carrier (4). Unlike the cord carrier, which conveys traffic at a comparatively rapid rate for long distances, say from end to end of a large instrument room, the band carrier runs very slowly (about three fourths or seven eighths of a mile per hour) and is used for short journeys only—for example, to convey enveloped telegrams to the end of a delivery table at which the addressing staff are seated. For this purpose the band usually travels in a trough practically on the table top, as at "A," but in busy centres where a large number of printed covers are used it is sometimes necessary to raise it in order that it may travel above the case of pigeon-holes containing the envelopes. This arrangement is similiar to "B" (which is for a telephone record table) except that the tray is supported on the pigeon-holes instead of the pillars, and that the short brackets as at "A" are fitted beneath the table.

In the case of Trunk Telephone Exchange record tables the band has to be raised about a foot above the table, and also to clear the apparatus shelf about the same distance below the table.

The band now in general use is 2-ply rubber-canvas belt, which is supplied without visible joint and fully stretched before delivery; 3-ply cotton, Gandys, and balata belting have all been employed and cotton found to be the most suitable except for the thickness of the joint, which, as it necessitates a wide slot in the table top, allows messages, etc., also to pass through. Gandys and balata being

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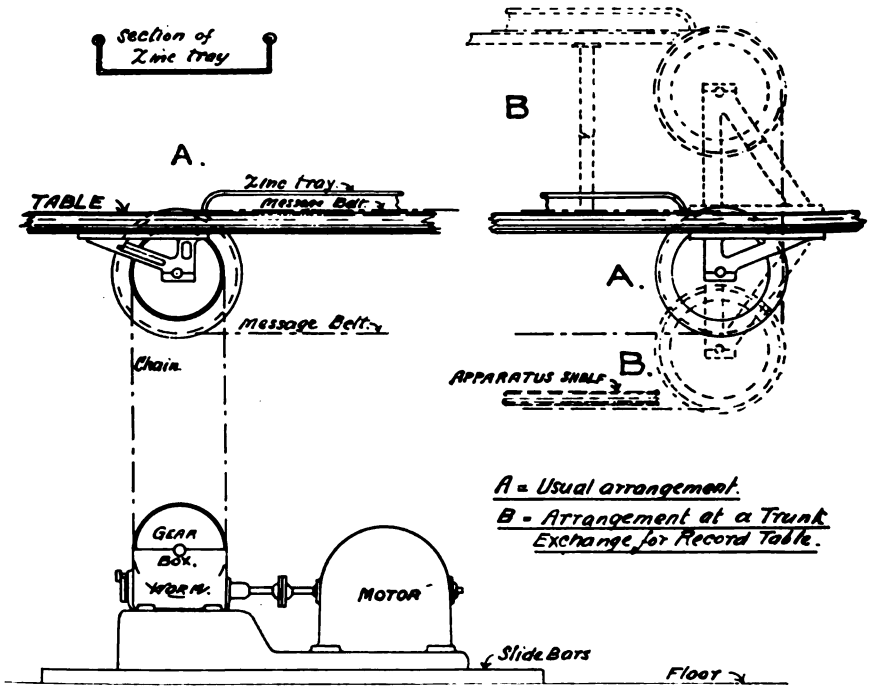
of a sticky nature and also becoming electrified during use were found unsuitable for the thin telephone tickets, which adhered to the surface, but they can both be obtained with a practically invisible joint. The rubber-canvas belt is apparently satisfactory in all respects.

The belt passes round drums about eight inches in diameter, one of which is fitted with a chain-wheel and roller chain. The motor shaft is fitted with a worm driving a worm-wheel in an enclosed oil bath, and the worm-wheel carries a chain-wheel geared level with that on the belt drum. The spacing of the belt drum is adjustable



4.—Band Carrier.

by means of slots in the supporting brackets, and the chain drive is regulated by sliding the motor along in the traversing rails or slide bars.

Ten band carriers are in use at the present time, viz.: six telegraphic at London C.T.O., London Stock Exchange, Manchester and Birmingham. Four telephonic at London, Liverpool, Manchester and Glasgow.

The band carrier seems happily to have escaped the scathing criticism received by its more active, though until recently less silent relative, and in support of this statement the Editor of the 'Telegraph Chronicle' will, I am sure, pardon me inserting the following verses, which appeared in his issue of November 3rd, 1905:

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ODE TO THE DELIVERY TAPE.

"Oh, Tape, you make me dizzy with your ceaseless silent flow;
Like some dark and muddy river on your way you daily go.
And if we're clear, and thankful for one moment to be free,
Your constant motion seems to say, 'Don't stop, keep on like me.'

"You seem so calm and heedless when they rave about delay,
You make no sound or murmur, yet I wonder every day
As I watch you gliding past me on official business bound,
If you ever feel you've had enough of running round and round.

"If you ever think it's weary work and feel you'd like a change—
If you're really quite contented, I think it's very strange—
But p'raps, like us, you've found ere now that tho' it's sad, it's true,
There's not much use in getting tired of what you have to do."

POST OFFICE ENGINEERING DEPARTMENT, LONDON: SIXTH ANNUAL DINNER.

THE above dinner was held at the Grand Hotel, Trafalgar Square, on Tuesday, February 16th, 1909, Major O'Meara, C.M.G., Engineer-in-Chief, presiding.

The guests of the evening included the Right Hon. Sydney Buxton, M.P., Postmaster-General; Sir Henry Babington Smith, K.C.B., C.S.I., Secretary; Mr. A. F. King, C.B., Mr. H. S. Carey, Mr. A. M. J. Ogilvie, Mr. C. A. King, Hon. R. D. Denman, Colonel Price, C.M.G.; Mr. W. M. Mordey, President of the Institute of Electrical Engineers; Dr. Walmsley, Dr. Fleming, Mr. F. Gill, Mr. E. A. Eames, Mr. F. E. Evans, Mr. J. W. Willmot, Mr. A. W. Heaviside; etc.

After the Royal toasts had been duly honoured,

The POSTMASTER-GENERAL (who was received with loud applause), rising to propose the toast of "The Engineering Department," said:

Major O'Meara and Gentlemen,—This is, I believe, the fourth time I have had the honour as Postmaster-General of dining with the Engineering Department.

I have on these occasions quite rightly to congratulate your Department on the work of the past year, and on the energy, zeal, and efficiency put into the work. I do it with perfect honesty and with real feeling. It is sometimes difficult in these matters to compare one Department with another. I feel on the present occasion like the mother who saw her son rowing in an eight, and

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called out, "Why, Billy is rowing faster and better than anybody else in the boat." The Engineering Department, at all events, certainly deserves well of the great Department over which I have at the present moment the honour to preside.

There are, perhaps, a few things to discriminate the Engineering Department from other departments. In the first place no other department has constructed and maintained a million miles of wire. You also, I think, have perhaps rather more revisions and rather more delay in revisions almost than any other department. Somebody has said that the revisions of the Post Office were slow and sure. A member of the Department, however, has said that they were not always sure, and certainly they are always slow, and I regret that I am unable at the present moment to say that the latest revision, which I hope may improve the opportunities of the Department, has yet gone through the various stages to which revisions are due. I had hoped to be able to announce it this evening.

I am glad to be here to-night, because this dinner represents practically the first year of the new Engineer-in-Chief to the Post Office, my friend Major O'Meara. (Applause.) I wish to congratulate him on the great success which attended his attendance and that of Messrs. Purves and Hill at the Buda-Pest Conference, representing the various administrations interested in telegraph and telephone work, the great success of that Conference, and the effect and influence of the British delegates on that Convention. (Applause.) We have also made this year, thanks largely to the action of the Engineer-in-Chief, great strides in one section of your Department —that of wireless telegraphy. I am glad to think that the Post Office has now opened a very efficient and very effective wireless telegraphy station at Bolt Head, and we believe that we are likely from that to extend our operations in other directions. I think that wireless telegraphy will be one of the considerable tasks for the Engineering Department to undertake. Wireless telegraphy is becoming of vast importance, and what is equally important in some ways, it has taken hold of public imagination, because the other day the collision between the "Florida" and the "Republic" drew very active attention to the advantages of wireless telegraphy. It is rather curious that up to now one of the disadvantages always alleged against wireless telegraphy was that if you sent a message in one direction it really went in other directions and secrecy was impossible. But on this occasion this proved a great advantage. The one message by being sent in every direction was actually communicated at the same moment to no less than four separate ships, all of which were able to get into communication. What was supposed to be a disadvantage was an extreme advantage.

As regards the telegraph, I noticed the other day that the

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longest distance telegraph message actually without a break was from Calcutta to London, a distance of 7000 miles. That, I think, shows the great strides taking place in that respect. (Applause.) As regards our telegraph system in England, I am glad to say that you are also making very considerable additions day by day to our underground work for the protection of our telegraph lines. I think it is satisfactory and a compliment to the good work which the Engineering Department have put into the construction of their lines, that when we had that almost phenomenal snow-storm the other day, with very few exceptions no telegraph lines were put out of operation. Those that were, the extraordinary rapidity of the Engineering Department very soon brought back again into working order.

I understand you have two difficulties to contend with, one as regards your overhead wire lines and the other as regards submarine cables. In the case of the overhead lines, it is the common or garden boy who throws stones at insulators and breaks them, and in regard to the submarine cables, a small animal which bores into them. The Latin names of the two animals which are your chief foes are *puer vulgaris*—I suppose representing the boy, and the other animal—the size of a pin's head—seems to rejoice in a somewhat longer name. This animal is called the *Teredo navalis*, and if you in your peregrinations meet a *Teredo navalis*, I hope you will put your heel upon it and kill it at once. (Laughter.)

Another point; from the legislative point of view the construction of telegraph and telephone lines has made considerable progress. Up to now we have not really had sufficient authority in the country districts for either the construction or maintenance of our lines or for the proper lopping of trees to make them efficient. The Telegraph Construction Bill has been for many years a hardy annual. Last session I carried the Bill through the House of Commons and got the Royal Assent to that Act. (Applause.) At the present time we are in the position of being able to say to a capricious individual who objects to the telegraph and telephone lines being brought from one place to another, and who does it on no reasonable grounds, that we insist on our lines being brought in that direction. We desire that the amenities of the country will not be disturbed, and as far as possible the feelings of land-owners will be considered. I am glad to think that one of our erstwhile obstructors in this direction who has been some years a great inconvenience—costing literally thousands—caved in as soon as the Act was passed. We are now very good friends with him. But, on the other hand, a day or two ago a rather serious difficulty arose because the Postmaster-General issued a notice to Mr. Sydney Buxton, living in Sussex, to say that he was going to lop his trees. Mr. Buxton did not like it—

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did not want his trees lopped by the Postmaster-General. The question was rather serious. However, the Postmaster-General and Mr. Buxton met, and with one of your principal engineers I am glad to say that without any necessity for reference to the Telegraph Construction Act, or for calling in Sir Robert Hunter on either side, an amicable arrangement was concluded, and both the Postmaster-General and Mr. Sydney Buxton were satisfied with the result. (Applause.)

There is one other matter, which concerns Mr. Morgan's Department rather than yours. We have been endeavouring during the past year to obtain telegraph and telephone poles from home sources rather than from Norway and Russia. I hope that in time, as the land-owners get to appreciate that we should like, if we can, to get them from home sources, they may meet us on that point. The difficulty is in your Department. Though I perpetually tell the Engineer-in-Chief and such engineers as I have the opportunity of meeting that the telegraph and telephone poles are far too large and might be half the height, every time I see a new line put up the poles have grown instead of diminishing. However, I am glad to know that the department are starting on a new artistic line. Some time ago I offered a prize, in joke, for an ornamental pole which would combine utility and cheapness, be well designed, and that would also appeal to the æsthetic feeling of the local authorities. In some cases they have got a very slight taint of the æsthetic feeling. I was glad to find that the Department has started out to enter the competition and win the prize. I hope it is quite a legal competition, because I should not like to do anything illegal, especially if it goes by post. I have now some poles which, with considerable modifications, I think may possibly pass as perhaps a little more beautiful than the ordinary pole. I find they are proposing an ornamental top, a wooden middle and an iron foot. I think if the design at the top is somewhat modified, the middle slightly altered and the iron foot somewhat changed, the suggestion may meet with my approval from the æsthetic point of view. (Laughter.)

Then it was suggested to me that one way in which we might cover up the deficiences of the Engineering Department in the matter of poles was by growing creepers up them. Somebody wrote to me and suggested that we should grow flowers and creepers up our telegraph poles, and said that it would be so very nice for the local rural postman as he passed by them to water them and nail them up the poles. I may think, as an experiment, of trying them on those poles which Mr. Buxton agreed to have over his estate.

Another suggestion, but more practical, is that of utilising our telegraph poles for advertising purposes, and that both pills and soap

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should be publicly exposed on the telegraph poles. I am always in want of money for various proposals, and if the telegraph poles will bring me in sufficient revenue, for instance, to reduce the postage to France from 2½d. to 1d., I shall be obliged to the Engineering Department.

Apart from that question, I am glad to see our friend Mr. Gill here as representing the National Telephone Company. We are also looking forward to the time when we shall take over the National Telephone Company, including, perhaps, Mr. Gill, and I hope that we may be able in the interval to smooth over the difficulties, which are great on both sides. I hope between now and then that the friendly relations—which I am glad to say exist between us—may be continued, and we may be able to come to some arrangement to carry on the construction work during the next three years, so that when the time comes for the system to be taken over by the State, it may be in a proper and satisfactory condition. By that time—three years hence—no doubt Mr. Preston's operators will have had time to learn proper manners. (Laughter.) As you know, he has issued instructions to them how they are to behave to the public. As far as I am concerned, I think that the incivility comes, not from the operators, but from the public who use the telephone (applause), and I hope I have Mr. Preston's approval when I tell him that I think that the suggestions made to the telephone operators might be issued as a manual to the public to tell them how to treat his operators and to be civil to them.

One other point to which I want to refer is the Institution of Post Office Electrical Engineers. I want to refer to it for this reason. I had the pleasure lately of presenting and distributing the medals and certificates to the members, and I was very glad to be able to congratulate them on the great success which has attended its efforts, and I hope that the Institution will receive the greatest possible support from the engineers of the Engineering Department. I am sure it is of the greatest possible use. In that connection I think we are also under an obligation to a guest of ours this evening, Dr. Fleming, for the lectures he has given lately in regard to wireless telegraphy and so on, which, thanks to the liberality of the Department, some engineers have been able to attend.

The toast which I have to propose to you is that of "The Engineering Department," coupling it with the name of your Chairman, and though to me the mysteries of telegraphy and wireless telegraphy are real mysteries, none the less I do, as the head of this Department, feel the greatest possible interest in the work which you are undertaking, and I congratulate you heartily and genuinely on the excellent and efficient way in which that work is done. I thank you for having asked me here as your guest to-night. (Applause.)

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MAJOR O'MEARA, in responding, said:

Mr. Buxton, Sir Henry Babington Smith, and Gentlemen,—Before replying to the toast which the Postmaster-General has so kindly proposed, I will read a letter which I received from Sir William Preece yesterday:

"MY DEAR O'MEARA,—I am very sorry to tell you that I cannot come to the dinner on Tuesday. My chill has been very troublesome, and I did great harm to myself by going up to town last Tuesday and Wednesday. My doctor has given me strict orders to keep to my room, certainly until Thursday next. It grieves me very much, for to-morrow I enter my 76th year, and I wanted my old colleagues to see that I am still as fresh as on Transfer Day—39 years ago—and as keen as ever in watching and appreciating the progress and success of the Engineering Department of the Post Office. I regret also that I have not the opportunity to express my very high opinion of the work done by the Institution of Post Office Electrical Engineers. I wish you all a very pleasant evening."

Well, gentlemen, I replied to that letter this morning to say that the whole Engineering Department and myself very much regretted his absence from the table to-night. (Applause.)

I am sorry to say that at the last moment Sir Robert Hunter has been unable to be present. Owing to a slight accident he has been ordered to rest an injured foot.

I have also received a telegram from a meeting of the North Wales Centre of the Institution of Post Office Electrical Engineers at Liverpool, sending greetings and best wishes for a pleasant evening.

I think it is quite needless, gentlemen, for me to say that we very much appreciate the presence of the Postmaster-General here this evening. We know what a very busy day it has been for him, and we quite recognise, I take it, when accepting an invitation that the knowledge that he will have to make a speech must rather put him in a trying position, especially when he has to be present at so many dinners in so short a time as he has in the current month.

The Postmaster-General has referred to the Buda-Pest Conference. Speaking not only for my colleagues—Messrs. Purves and Hill—but for myself also, I may say that we have felt it to be a very great privilege indeed to place before our foreign colleagues the work that is being done by this great Department. (Applause.) And I am quite sure that the gathering at Buda-Pest will have far-reaching consequences.

We were not only received with the very greatest kindness by the officials of the Hungarian Administration, but we had only to express a wish to see something or to know something and the next day a motor-car was at our disposal, or the information was given us, and before we left we were put in possession of all we wished for.

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Within the last few weeks the Hungarian Administration has sent a letter to me informing me that the French Government had issued an invitation for the next Conference to be held in Paris in 1910, and I have been authorised to accept that invitation.

I may say, in connection with the Buda-Pest Conference, not only were there delegates there representing governments, that is to say, officially, but there were also officers of some administrations there who had come on leave. Paris is not very far from here, and I hope that unofficial delegates will also be admitted to the Paris Conference, and some of our officers may in that way be able to take part in the proceedings. (Applause.)

I should like to refer, gentlemen, to the fact that we have present here the President of the Institution of Electrical Engineers. (Applause.) We cannot forget that this Institution was founded by the pioneers of the telegraph industry, and therefore, gentlemen, I think it is a very good thing that the present holder of the position of President is himself an ex-Post-Office official. And I am quite sure that it is your wish that I should offer our congratulations to Mr. Mordey in having attained that position. (Applause.)

Among the successes gained by officers of the Engineering Department during the past year, I should like to refer to the fact that three of our officers have obtained the degree of Bachelor of Science—Messrs. Addey, Matthews, and Rivers-Moore.

The Postmaster-General has referred to the Construction Bill, which has certainly already helped us to a considerable extent.

We had a very long correspondence with a certain lady, who does not live very far from London, who for a long time had been obdurate. The new Act came, representations were made to her, but still without effect. It became necessary for our solicitor, who does not write quite in the ordinary style, and is given rather to archaic phraseology, to serve a notice on our recalcitrant correspondent. She probably did not quite understand the purport of the letter, but was convinced that the time had come for her to take some action, and she sent a reply which ends: "As far as I am concerned you can put 40,000 poles, or anything else you like, up, down, along, across, or all over the road; it is a matter of absolute indifference to me." I may say, gentlemen, we shall not be able to use this consent in the general sense that the lady implies.

Well, gentlemen, I think that all I can do is to offer your very sincere thanks to the Postmaster-General for the kindly way in which he has referred to our efforts to do our duty. (Applause.)

Mr. Catley proposed the toast "The Visitors," coupling with it the names of Sir Henry Babington Smith and of Mr. W. M. Mordey, President of the Institution of Electrical Engineers.

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Sir HENRY BABINGTON SMITH, K.C.B., C.S.I., in replying for "The Visitors," said:

Mr. Chairman and Gentlemen,—The admirable arrangement which enables me to share the responsibility of responding to this toast with so distinguished a visitor as Mr. Mordey, gives me, I will not say an excuse, but an excellent reason for a brevity which you will all commend.

I represent here for the moment your visitors, and it has fallen to me, in common with Mr. Mordey, to thank you for the hospitality which we have enjoyed so much, and for the manner in which you have received the toast which has just been proposed. I do so most heartily, representing in the first place the Postmaster-General, and as duties—I will not say more agreeable duties—in the House of Commons have called him away, I can perhaps speak of him with more freedom than I should have been able to do in his presence. I think that the Engineering Department, as every branch of the Service, has felt the strong personal, and I may say human interest which the Postmaster-General takes in every branch of the great Service of which he is the head. (Applause.) I am sure that the whole Service appreciate that.

As regards the engineering service, we have special reason to be grateful to him for his success in the somewhat difficult task of persuading the House of Commons to pass useful legislation. The Telegraph Construction Act has already been mentioned, but I should like to add this was not the only useful piece of legislation for which he was responsible. He was responsible for the Act renewing and extending the Government's control over Wireless Telegraphy—the Wireless Telegraphy Act—and, perhaps still more important, he persuaded the House of Commons to pass, before the present exigencies arose, an act providing an ample supply of capital for the development of the telephone system. (Applause.)

Gentlemen, I represent also, in the person of Mr. Gill, the National Telephone Company. In that capacity I feel myself projected into the future. I place myself prophetically on January 1st, 1912; but then I recollect that if that were so, and if Mr. Gill were present, it would probably not be as a visitor.

I represent also other distinguished visitors: Dr. Fleming, the scientific advisor to the Marconi Company, representatives of the great Cable and Telegraph Companies and others; and all of us we thank you most heartily for your hospitality to-night.

It is a great pleasure to take part in the annual gathering of a great Department, which is essentially alive. (Applause.) The work of the Department is increasing, and broadening and developing in many directions, and a Department which has to cope with work of that kind is necessarily changing, developing and altering

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itself to meet the circumstances. Without recapitulating what has been said to-night, I think we may congratulate the Department on a most successful year's work under the direction of your Engineer-in-Chief. It is a great pleasure to be present as a guest at the second dinner over which he has presided as Engineer-and-Chief and as head of your great service. (Applause.) Under his distinguished guidance I look forward to a most prosperous future for that service. Gentlemen, I thank you once more. (Applause.)

Mr. W. M. MORDEY, M.Inst.C.E., President of the Institution of Electrical Engineers, also replied for "The Visitors." He said:

I am sure you will appeciate how highly I value the honour of being here to-night when I tell you that I am here against my doctor's orders, and have come five hours' journey to be here.

I was particularly anxious to come, because I felt that being here I should be amongst friends. I am an old Post Office man. I do not forget that I began my electrical work by eleven years as an operator in the Post Office, and that I have many friends who have remained in it. I am glad to see here to-night my old schoolmaster, Mr. Probert, who taught me telegraphy at the Telegraph School in Cannon Street—I think it was in 1873 or 1874. Since then I have had friendly relations, I am glad to say, with every Chief of the Post Office Engineering Staff. I never met Mr. Culley, but I have had the pleasure of working with Mr. Graves, Sir William Preece, Sir John Gavey, and now with you, Major O'Meara, and other Post Office friends, such as Mr. Heaviside, and my old chief at Bradford, Mr. Gilpin, to whom I should like on the present occasion to offer my thanks for many kindnesses.

I always think with gratitude of the action of the Post Office when I left its service. At that time I was eking out my small pay by teaching classes in science and technology in the North of England, and when Electric lighting came to the front in 1881 I made application to the Postmaster-General for six months' leave of absence to see if I could find something better to do. I said that if unsuccessful I wanted to come back so that I should not lose my eleven years towards a pension, and the Postmaster-General generously gave me that leave of absence.

Speaking here to-night as President of the Institution of Electrical Engineers, which now numbers over 6000 members, and that began in 1871 as the Society of Telegraph Engineers, I may, perhaps, be allowed to say that I and all the other members of the Council regret that to-day telegraphy occupies so small a part in the work of that Institution. We feel that as an Institution we are broad enough to cover and to include all branches of electrical engineering, not least those associated with your work.

In our new building on the Embankment, before the year is out

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—I am speaking on my own account—I hope we shall be able to offer hospitality to the Institution of Post-Office Electrical Engineers. And as a believer in the truth of the old adage that union is strength, may I also say that I hope that that hospitality may some day grow into a closer and more intimate connection. (Hear, hear.)

I am told that the reason why so few of our members are telegraph men is that modern electrical engineering does not interest telegraph engineers, and that the two branches are separate and apart, that a man can be a very good telegraph or dynamo and power engineer without knowing anything of the other branches. That may be true, but I also say that a telegraph engineer will be a better telegraph engineer if he has the knowledge and follows the progress of work in the other branches of electrical engineering. (Hear, hear.) I believe, and I believe very strongly, that there are many improvements to be made in telegraphic and telephonic work by men who have been brought up in heavy electrical work. I should like to give one example only. There was a young man whom I know as a draughtsman and designer in a dynamo works. He was getting small pay and was not satisfied. He was ambitious and able. Through a certain action of mine in connection with a patent a little money came into his hands. He came to me and said that now he had got this money his wisest course was to go home and study telegraphy, that there was more in telegraphy than in heavy engineering. He went home. Not long afterwards he came to me and asked me to go and see his cable relay. The young man's name was Sidney Brown. (Applause.) By applying to submarine telegraph work ideas and knowledge obtained by the study of heavy engineering conditions he was able to solve a problem that had for many years baffled Kelvin and other telegraph men. I mention this now because I want you to realise that it is a mistake to suppose that you can have water-tight compartments between different branches of our profession. (Applause.)

May I turn to another subject. I am very glad to be here to congratulate you on being the members of what I think is the most satisfactory State service in the world. I do so for a particular reason. I believe the day is coming when we shall have State railway control, that all great national services will be controlled by the State, and must be so, and I think in the splendid service you give you afford the best possible answer to the objections made to the transfer to the State of the railways.

I thank you on my own behalf and that of the other guests here whom I represent for the honour and the pleasure you have given us in asking us to be your guests to-night. (Applause.)

Mr. I. PROBERT, rising to propose the toast of "The Chairman," said: My esteemed colleagues are always ready to support a good

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cause. They "rejoice with them who do rejoice." To be happy together is our highest ambition, and the most elevating hope which can inspire a human being is to make others happy. The London Post Office Engineers delight to foster harmonious conviviality and implicit trust in their Chief. It is the true spirit of duty to ably and cheerfully support our Chief, and by upholding him we elevate the whole status of the Department to which we belong.

When we reflect upon the magnitude of the Engineer-in-Chief's responsibility, the gigantic organisation of the Engineering Service, and I may say the manifold generalities of the whole service he is at the head of, we must acknowledge that he readily deserves our most zealous aid in successfully carrying on the requirements of the Post Office Engineering Department. The Post Office Engineer's motto should be "*Nulli Secundus*," and my opinion is that there is not a better body of Engineers in the whole world than those in the Post Office Service.

I remember hearing our revered past Chief Sir William Preece many years ago tell a good story of the telephone. It was when the telephone first came into practical operation. He was dilating upon the marvellous powers of that instrument in transmitting the timbre of the human voice, and, as usual, to prove his point he rang up a friend and said, "Do you know who I am?" "Yes," was the answer, "and I can smell your cigar." Well, now, I am inclined to think that if we were in a position to-night to transmit by the aid of electricity the aroma of a cigar, our worthy Chairman would only be too delighted to waft the fragrance of good fellowship from this room to his predecessor Sir John Gavey. There is much more to be said, but, as our time is short, I will conclude my remarks by saying that I have much pleasure in proposing the toast of our Chairman. We hope that he will enjoy good health for many years to come, and that on some future date he will be able to say, as Sir William Preece said at one of our annual gatherings, that "the Post Office Engineers are always dear to my heart." (Applause.)

Major O'MEARA, replying to the toast of "The Chairman," said:

I have to thank Mr. Probert for the very kind words in which he has proposed my health, and for the hearty manner in which you have received it. I feel that, perhaps, the Engineer-in-Chief is only a bit of useless ornament, and really he does very little work, no more than the cross on St. Paul's Cathedral, and if it were not for the foundations and for the columns which support the cross, well, the cross would not be there! I feel I am more or less in that position, and although I may be exposed to the storms, it is your support which enables me to maintain my position. Again I thank you. (Applause.)

Special arrangements for the reception and for the comfort of

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the guests—about 180 in number—were made by the manager of the Grand Hotel, and the dinner was excellent.

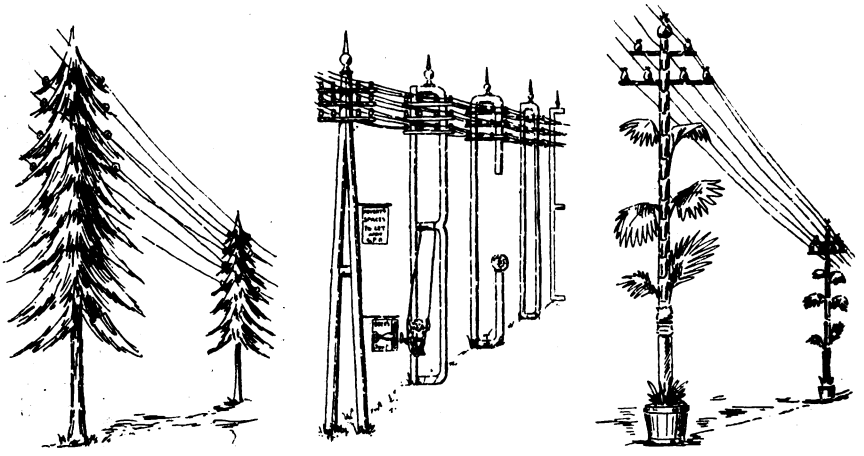
An enjoyable musical programme was sandwiched between the toasts, in which Messrs. Willmott, W. H. Matthews, B. M. Brown, and S. Levey (all members of the staff) ably took part.

The general arrangements were under the direction of Secretary of Committee Mr. H. North, and they worked with a smoothness which has now become characteristic of these gatherings, and for which Mr. North is entitled to hearty congratulation.

ORNAMENTAL POLE DIVERSIONS.

IN response to Mr. Buxton's wish for an æsthetic telegraph pole three designs, illustrated below, have already been submitted to the Editors of the JOURNAL by Mr. J. Moir.

It will be observed that the middle one combines the provision of instruction and amusement for *puer vulgaris*, and would, therefore, tend to divert the animal from its ordinary insulator-destroying pursuits, while, if either of the other designs becomes the standard, landowners will compete with each other in the endeavour to induce the Department to divert its lines from the roadways to their demesnes.



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NOTES AND COMMENTS.

Engineering Department Annual Dinner.

Elsewhere we deal fully with the sixth Annual Dinner of the Engineering Department, which was held at the Grand Hotel, Trafalgar Square, on February 17th.

It is gratifying to state that the attendance was larger than on any previous occasion, with the exception of the farewell dinner to Sir John Gavey, C.B. The Engineer-in-Chief, Major O'Meara, C.M.G., occupied the Chair. The guests included the Postmaster-General, Sir Henry Babington-Smith, K.C.B., C.S.I., and the President of the Institution of Electrical Engineers, Mr. Mordey. Most of the departments in the Post Office were represented by their chiefs. It was, however, a matter of regret that neither Sir William Preece, K.C.B., nor Sir John Gavey, C.B., were able to attend.

As on previous occasions at the Grand Hotel the dinner was well served, and the general arrangements were admirable.

If there was anything to criticise it was the speeches. The impression we were left with seemed to be that none of the speakers cared to let themselves go. Possibly the disappointment was due rather to the fact that previous dinners have been made the occasions for announcements closely affecting the life of the Department, but this time we were sent empty away.

The musical items were individually good, but the programme as a whole was rather heavy, and might have been better arranged. Where are the lady singers who used to lighten the evening's entertainment?

It is only fair to say how the success of these dinners has been dependent on the energy and foresight of Mr. Harry North, the Honorary Secretary to the Dinner Committee, and to him thanks are due for the successful arrangements made.

Our Frontispiece.

We are indebted to Mr. G. W. Hook, Superintending Engineer of the South Midland District, for sending us the fine photograph from which our frontispiece has been produced. The shelter-tent shown in the picture is of the type introduced by Mr. Hook—to replace the stretched tarpaulins of other days—and now used all over the Kingdom. We shall be glad if other readers will favour us with photographs of such scenes.

The interest—indeed, the romance—of the telegraph engineer's life still waits for an able chronicler, and when he arrives our pages will give him welcome.

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The Sub-Engineers' Examination.

Considerable interest will doubtless be evinced in the results we publish of the Sub-Engineers' Examination. It is another and important step in the working out of the destinies of these officers. It will be remembered that, as a result of their representations before the Select Committee of the House of Commons in 1906, it was decreed on January 1st, 1908, that *future* sub-engineers would, if efficient, be promoted to engineerships at the end of three years, but the fate of the existing members of the body was left in doubt. Subsequently it was announced that the eligibility for promotion of those sub-engineers who had passed the three years' limit would be tested by a Civil Service examination, and this was held on January 26th, 1909, and following days. We congratulate heartily those whose names are included in the list of successful candidates.

To those others to whom the event has been a severe disappointment we would also say a word. We are glad that another opportunity to qualify is to be granted them, and that if successful their seniority will be retained. We hope they will take courage, and determine to extract future good from present failure.

It is for their comfort that we reproduce in abstract an excellent leader from the columns of the 'Daily Telegraph,' which presents the subject of "Examinations" from a point of view not frequently met with, but none the less wise and true. While we are in full agreement with the writer that "Nothing but the prolonged ordeal of real life can show the real man," we adhere to the views expressed in a previous number that in dealing with large bodies of *junior* officers, examinations are necessary as a test of *unfitness* and to prove the possession of a minimum equipment of mental tools.

It has been unfortunate for many officers that the test has not come at an earlier period in their life, while others have been adversely affected by the change in the type of examination, and all have suffered from the natural antagonism which exists between absorbing official duties on the one hand, and the time necessary to acquire material and agility for academic competitions on the other. In any case we reiterate our hope that they will yet triumph over their misfortunes.

Paris Conference, 1910.

In connection with the Second International Conference of Telegraph and Telephone Engineers to be held in Paris in 1910, we are pleased to be able to give our readers an advance list of the subjects with which it is proposed to deal. They are as follows:

(1) Telephone Service: Manual *versus* Automatic.

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(2) (*a*) Standardisation of Telephonic Circuits; (*b*) Choice of the Frequency, and eventually of the Voltage, at the Terminals of the Secondary, with a view to the Assimilation of the Telephone Currents to a Sinusoidal Current, in order to unify Theoretical Studies; (*c*) Conditions of Adaptation of Telephonic Apparatus to the Lines; Induction Coils, Microphone Resistance, etc.

(3) Co-existence of Circuits carrying Strong and Feeble Currents on adjoining Lines (methods of preventing inductive and other influences).

(4) Long-Distance Telephony: Construction of Cables for Long Distances; Repeaters; Combinations of Aërial Wires.

(5) Wooden Poles: New Processes for Preservation by Impregnation and other Productive Methods; Descriptions of Practice.

(6) Party Lines and Selective Signalling on Telephonic and Telegraphic Circuits.

(7) Telegraphic Systems for Heavy Traffic: Multiplex Machine Telegraphs and the Mercadier System.

Names for Units.

In our last number we had an account of the proceedings of the International Units Conference, which met in London for the purpose of defining the quantities which shall be used for various electrical units. This Conference, after deciding that the ohm (defined as the resistance of a column of mercury of uniform cross section, 106·300 cm. in length, and having a mass of 14·4521 gms.) shall be the first primary unit, that the ampère (defined as the unvarying current which deposits silver at the rate of 0·00111800 gm. per second) shall be the second primary unit, and that the volt shall be derived from the two latter, appointed a scientific committee of fifteen to direct work in connection with the maintenance of standards, fixing of values, and inter-comparison of standards.

We have rehearsed this, to emphasise the fact that the Conference confined itself to *values*, and in order that we may point out that there are important matters in connection with the *names* of units which have long waited attention, and express a hope that the Committee may give them this attention at an early date. Take the case of the units used in connection with the law of the magnetic circuit, now familiarly referred to as the "ohms law" of the magnetic circuit. There can be no doubt that the absence of names for the practical units has greatly retarded the spread of knowledge of this subject. The term "magnetomotive force" was introduced by Bosanquet, and Oliver Heaviside gave us "reluctance," but no international agreement has yet been arrived at as to the names for the units of these quantities.

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At the Paris Congress of 1900 "Maxwell" was adopted as the name for the unit of magnetic flux at the same time that "Gauss" was chosen for flux density, but no progress was made in connection with names for M.M.F. and reluctance, although the suggestion had been made in 1894 at the American I. E. E. that "Gilbert" should be chosen for the former and "Oersted" for the latter.

These names seem quite appropriate, and we hope the Committee will hasten the day when—

$$\text{Maxwells} = \frac{\text{Gilberts}}{\text{Oersteds}}$$

will be as familiar to the schoolboy as—

$$\text{Ampères} = \frac{\text{Volts}}{\text{Ohms}}.$$

We have in mind another case where the need for a unit name has become acute, but it is probably too remote from the point at which the newly appointed committee will operate, and more suitable for the consideration of the Paris International Conference of Telegraph and Telephone Engineers, providing that America is represented.

Those who are much concerned with telephone transmission problems find that confusion is continually occurring owing to the use of the word "miles" in connection with units of standard cable. For instance, a certain circuit 100 *miles long* is equivalent to 5 *miles of standard cable.* Again, two telephone circuits are compared, and the audibility obtained over the first is equal to that obtained over 20 *miles of standard cable*, and over the second equal to 10 *miles of standard cable.*

We are of opinion that the confusion resulting from the use of the name of the unit of length might be avoided by adopting a name for the unit of standard cable, and that a suitable name would be "Pupin."

In the case where local system circuits connect with trunk circuits, we should then be able to say, "where the radial length of the junction circuit plus the radial length of the subscriber's circuit, does not exceed nine miles, the allowance is 5 pupins, where it exceeds nine miles the allowance is 8 pupins."

If the reader will repeat this, substituting "miles of standard cable" for pupins, he will realise how confusing the present practice is.

The matter is one of importance, and we shall be glad if interested readers will favour us with their opinions on the subject.

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EXAMINATION OF SUB-ENGINEERS FOR SECOND-CLASS ENGINEERSHIPS.

THE undermentioned officers qualified at the examination held by the Civil Service Commissioners on January 26th, 1909, and following days.

Sub-Engineers.

Mr. C. Leigh	Mr. W. C. Burbridge	Mr. J. Hume Bell
„ H. E. A. Wenman	„ W. Cruickshank	„ R. N. Partington
„ J. R. Crocker	„ T. Cobbe	„ W. Vickery
„ J. A. Jack	„ G. H. A. Wildgoose	„ W. V. Ryder
„ J. McCandless	„ G. Bowyer	„ W. Day
„ A. Evans	„ J. Waller	„ F. E. Mitton
„ J. W. Turner	„ A. E. White	„ W. E. Tremain
„ C. E. Hay	„ G. T. Fisher	„ J. Hope Bell
„ H. O. Aspinall	„ D. McE. Smith	„ A. Wynne-Jones
„ C. E. Pollock	„ J. I. Smith	„ A. J. Pratt
„ D. S. Arundel	„ J. D. Stanton	„ H. O. Fleetwood
„ J. S. Elston	„ J. Buchanan	„ C. G. A. McDonald
„ J. A. Morgan	„ P. J. Childs	„ P. F. Attrill
„ W. H. Calveley	„ H. W. White	„ H. R. J. Dunthorne
„ A. Rattue	„ H. J. H. Tabor	„ O. P. Moller
„ F. Lock	„ J. B. Laidlaw	„ H. G. Beeton
„ G. Hunter	„ G. Balchin	„ J. Coxon
„ W. Dolton	„ A. S. A. Johnson	„ A. W. Bartlett
„ E. J. T. Newton	„ F. McClarence	„ F. A. Linsell
„ A. W. Field	„ E. P. Neate	„ W. Deane
„ G. Cowling	„ W. Atkins	„ C. N. MacDermott

Relay Clerks.—J. Davey; A. Fraser.

EXAMINATIONS.

THE following is abridged from the leader columns of the 'Daily Telegraph' of February 27th last:

"Mr. Balfour has always attached the maximum of importance to reflection and the minimum to formulas, and he touched a congenial theme when contending, at the meeting of the Carnegie Trust, that examinations are an imperfect test of ability. That simple truth is of considerable significance in all spheres of life, and neglect of it has done more than anything else to pervert the educational systems of nations nearer than China. To work for the purpose of answering papers with neatness or despatch, or of passing through the more impromptu ordeals of academic heckling, is to sacrifice the very object of the process to the method of it.

". . . The man who is a walking work of reference upon matters in general can scarcely hope to emulate the usefulness of two or three printed compilations, which any person may acquire at popular prices. Memory is in itself an immensely useful thing as

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long as even more important powers are not sacrificed to it, but to cultivate the art of memorising above every faculty is to pursue in effect the manufacture of mandarins and babus. Many persons of first-class equipment possess also the incidental gift of excelling at examinations, but will rarely be found to have owed any of their mental development to these tests. . . . In the arena of academic competition certain dexterous faculties are brought into play, no doubt, but not the best, and it is not unknown—it is even not uncommon—for the man who has been plucked to possess the strength of intelligence and character and the individual bent of mind which will ultimately enable him to soar above all those who have temporarily excelled him in memorised knowledge.

". . . The process of examination, in a word, may show something of what a man knows, but not even all that he knows, nor how long he will know it. Above all, it cannot reveal at all the real measure of that intellectual force which makes mere facts—the finished articles, as it were, of some minds—the raw materials of others constantly being worked up to higher powers of understanding and suggestion. . . . For creative energy of mind or character examinations supply a poor measure or none. That is why so small a percentage of persons who distinguish themselves so brilliantly in examinations distinguish themselves really in life. No amount of pat repetition can of itself carry things one inch further than they were before. We can only tell what is going to happen to a mind when we satisfy ourselves that it possesses or lacks certain qualities, which no amount of expertness in answering questions will necessarily indicate. Take the case of Darwin. There are profound meditativeness and earnestness of character, and—in a sense never excelled—the infinite capacity for taking pains. He gradually conceives an astounding theory, such as was not conceived, nor could at first be understood, by any person at that moment conducting examinations anywhere in the world. Here, then, we have that supreme power which does, and always must, elude examiners—originality. . . . We think of the case of Darwin, and of the giant labour required to establish his proposition. We have singled out one of the master-minds of all time, but similar qualities go to all considerable achievement. The power of continuous reflection, the ability to keep a fresh eye upon routine, and not to become enslaved to it, that quality of earnestness which makes interest intense and keeps it sustained—in a word, the intellectual vigour and staying power characteristic of the first-rate man—these are qualities which tell irresistibly in life, but are not disclosed by examination papers.

". . . Intuition, imagination, judgment, concentration, resolution, executive sureness, and rapidity—these are qualities characteristic of earth's demi-gods, but not less so in a different degree of thousands of those who at any given moment are taking the really directing part in the work of the world. Yet here again are the gifts of which competitive examination can give no true comparative assays. Some of these faculties may be possessed by those who fail, and not by those who pass. . . . When examinations have been held, after-life sifts out ability by a process of its own. Then, and only then, does it become clear to what degree a man is capable of taking initiative or rising to responsibility, of acting with "swift competence in emergency," of forming fresh ideas and bringing sufficient driving-power to bear upon the execution of them. The truth is, perhaps, that life is only beginning where examinations end. . . . It was Sir James Stephen who said, quite truly, that no man knows anything until he has learned it over again from a point of view of his own. A great deal of intellectual litter falls away unheeded when a man begins to grapple with his special work in life. His perseverance and force then come for the first time into play. He has to train himself over again. The passing and preliminary tests of the class-room may display the meanest efficiency of the candidate. Nothing but the more prolonged ordeal of real life can show the real man."

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INSTITUTION NOTES.

COUNCIL NOTES.

Meetings of the Council were held at Bedford on the 2nd December, 1908, and at York on February 3rd, under the chairmanship of Mr. A. J. Stubbs.

Reprint of Rule Book.

The Secretary reported that a reprint of the Rules of the Institution had been circulated to members.

Membership.

The membership to date is 827, made up as follows, viz.:

Number on Roll, 31st March, 1908		755
Resignations	9	
Deaths	2	
	—	11
		744
New members:		
Home	62	
Colonial	17	
Foreign	4	
	—	83
		827

Institution Award.

The President's suggestion that the Council should invite essays from members on a definite subject, and award a special medal for the best solution offered, is receiving consideration, and an announcement on the subject will be made in due course.

Circulation of Journals.

The new system of circulation of Journals has been brought into operation and is working satisfactorily.

LOCAL CENTRE NOTES.

EASTERN CENTRE.

The second meeting of the Session was held at Cambridge, on the afternoon of Wednesday, December 9th, 1908, when a paper was read by Mr. E. T. Titterington on "A Visit to a De Forest Wireless Telegraph Station (Hunstanton)." The chair was taken by the President, Mr. J. Jenkin, and there was again a very good attendance.

The subject was treated under three headings—(*a*) Theory, (*b*) Transmitting Station, (*c*) Receiving Station.

Under (*a*) the general theory of the propagation of electric waves was briefly explained, and the conditions limiting the distance over which the waves could be detected detailed. In this connection it was stated that at Hunstanton the effective

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range is greater during the winter than the summer, and during the night than in the day. Section (*b*) included a description of the method of constructing and erecting the mast, details of the apparatus installed, and an explanation of the various items and the method of operating. Section (*c*) dealt with the actions of the electrolytic receiver and of the coherer, both being in use at Hunstanton, and also the "tuning" apparatus.

The paper was illustrated by numerous excellent diagrams, for the execution of which Mr. Titterington acknowledged his indebtedness to Mr. W. Scarr.

A very satisfactory feature was the readiness with which the discussion of the paper was carried on. This contributed in a marked manner towards the success of the meeting.

NORTH WALES CENTRE.

The second meeting of the Session was held on the 19th January, 1909, when Mr. H. Hinton, of the Morfa Nevin Repeater staff, read a paper describing "Some Familiar Solenoids and Electro-Magnets in the Instrument Room." The author after briefly stating the theory of simple solenoids and electro-magnets, the permeability of iron and steel, and the use of the metals mentioned for cores of electro-magnets and for permanent magnets, described in detail the construction of the tangent and differential galvanometers, standard and non-polarised relays, E. M. switches, pony and polarised sounders.

The third meeting was held on the 16th February, when Mr. T. Plummer, Assistant Superintending Engineer, gave "A Description of the New Common Battery Trunk Equipment at Liverpool," illustrated by lantern slides. Mr. Plummer dealt with the subject in his usual thorough manner, and the time allotted (two hours) was insufficient for the completion of the interesting lecture.

Prior to the commencement of the meeting the members inspected the Trunk Exchange Equipment and the Power Plant, and Mr. Plummer placed his services at their disposal as demonstrator.

Mention should be made of the assistance rendered by Mr. J. G. Whiteside and Mr. W. R. Thomas in the preparation of the slides and the operating of the lantern respectively.

On the 16th March Mr. F. Horner will read a paper, entitled "Knots and Splices in their application to Telegraph Construction," and arrangements are being made to visit the Lancashire and Yorkshire Railway Company's Power Station at Formby.

The final meeting of the Session has been tentatively fixed for the 20th April, when Mr. G. H. Vaughan will read a paper on "The Economical carrying out of Works by the Concentration of Gangs." The annual dinner will be held on the same date, and it is hoped to arrange a visit to either the R.M.S. "Mauretania" or R.M.S. "Lusitania" prior to the ordinary meeting.

NORTH-EASTERN CENTRE.

The second meeting of the Centre was held on the 14th December, 1908, when Mr. Bailey read a paper on "Some Notes on the Huddersfield Underground Work." The paper proved of great interest, and showed how the difficulties, under which the work was carried out, were overcome. The subject of desiccation was treated at some length, and the result of the experience gained in this class of work will prove of value to engineers when faced with similar problems. A profitable discussion followed, and a cordial vote of thanks was accorded to Mr. Bailey, who attended the meeting at great personal inconvenience.

Mr. G. H. Hooles paper, entitled "Cost Accounting and Analysis of Cost," was read on the 18th January, 1909. The paper outlined an original scheme, claiming that it would be possible to build up day by day data for ascertaining the average cost of all kinds of works (maintenance and works orders), simplify unit cost accounting, and give the capital value of plant, etc. An animated discussion ensued, and the desire was expressed for the need of a system which would obviate the necessity for so many special returns.

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The 2nd February was a red-letter day in the history of the Centre, when its members had the pleasure of entertaining the Council of the Institution, which broke its journey to York in order to hear Mr. Carr's paper on "Aerial Lines, with Special Reference to the Elasticity Effects of Copper Wire." The meeting on this occasion was held in the lecture room of the Y.M.C.A., Leeds, and during an afternoon cup of tea members had an opportunity of renewing old acquaintances or of making new ones.

Mr. Carr in a few words expressed his pleasure and that of his staff in having the honour of a visit from the Council to Leeds.

Mr. Kempe being called to the chair opened the proceedings by stating that the meeting marked an epoch in the history of the Institution. This was the first time that the Council had been welcomed at the meeting of a local Centre, and he hoped that the visits would be continued. Such meetings enabled members to get into touch with each other, when, by personal interchange of ideas, information of a valuable character was diffused.

Mr. Carr then delivered his paper. He pointed out that the value of the official tables was seriously vitiated by the omission of the important factor of elasticity. The speaker gave examples of tables which he had prepared in which the factor of elasticity had been allowed for and showed that not only had misunderstanding arisen, but that many of the mechanical advantages of copper wire remained hidden, and consequently were not appreciated to the extent their importance justified. The advantage of the table of sags and stresses advocated by Mr. Carr is apparent, in that whilst allowing a good margin of safety at the lower temperatures, the sag at higher temperatures is not so much as at present shown, thus minimising the risk of contact faults. A case was also made out for the need of a heavier minimum gauge for copper wires on the Department's main lines.

An interesting discussion followed, in which many of Mr. Carr's arguments were confirmed.

The Council moved a vote of thanks to the local Centre, and the proceedings terminated.

NORTH-WESTERN CENTRE.

The meetings of tbe North-Western Centre continue to be interesting and well attended.

On the 21st December Mr. Guy read a paper on the "Manchester Electrical Exhibition," and specimens of new apparatus and appliances, with a working example of the Cooper-Hewitt lamp lent point to an interesting contribution.

On the 25th January Mr. Smith's paper on "The Chemistry of Telegraph Engineering" dealt principally with rubber, guttapercha, and wood preservatives.

Mr. Medlyn's second contribution to the proceedings of the Local Centre this session, viz., "The Localisation of Faults in Dry Core Cables" was presented on the 22nd February. It discussed in a practical way, the methods which had proved useful in tests of the kind, and showed how accurately faults could be located when the prescribed precautions were taken.

The last meeting of the session will take place on the 22nd March, when Mr. Lawson will contribute a paper on "The Manchester Trunk Exchange."

IRELAND CENTRE.

The second meeting of the 1908-9 session was held on December 14th, 1908, when Mr. Kinsey, Assistant Superintending Engineer, North Irish District, read a paper entitled "The Re-wiring of a large Telegraph Office."

There was a good attendance of members, and keen interest was displayed in the paper. A keen discussion followed the speaker's remarks.

On January 18th, 1909, Mr. J. J. Dwyer, Sectional Engineer, Waterford, contributed a paper on "Wireless Telegraphy." The paper was enthusiastically received and well

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discussed. Mr. J. H. Fossett, Assistant Superintending Engineer, South Irish District, presided.

Mr. Pennington's paper entitled "Central Battery Telegraph Systems" was read on February 15th, 1909. The subject was dealt with in a very able manner. Considerable discussion followed, in which a large number of members took part. Mr. Sheridan presided, and congratulated all present at the interest which is being shown in the Institute meetings. The attendances have been excellent considering the long journeys members have to make.

The last meeting of the Irish Centre is to take place on March 17th, when Mr. R. A. Weaver will give a paper on "Renewal of Open Wires."

NORTHERN CENTRE.

Four meetings have been held since the last number of the JOURNAL was published.

On December 14th Mr. J. A. Motyer read an interesting paper on "Paybills." The manner in which the subject was dealt with showed evidence of very careful preparation and intimate knowledge of the regulations governing it. An animated discussion followed, in which a large number of the members took part.

The fourth meeting of the Session took place on January 25th, Mr. A. G. Lee, B.Sc., being the lecturer, and his subject "Some Alternating Current Measuring Instruments." As was anticipated, the subject was treated in a very able manner. The lecture, however, took somewhat longer than usual to deliver, and there was not that opportunity for discussion which is desirable.

Our fifth meeting was held on February 22nd, when Mr. Bellwood delivered a lecture on "Central Battery Systems with Modifications." Unfortunately on this occasion the attendance was very small, only sixteen members putting in an appearance. It must be very disappointing to those who have given considerable time and labour to the preparation of a lecture to find that less than one third of the members are present. It is to be hoped that an improvement will take place in this respect, otherwise it is feared that some difficulty will be experienced in obtaining promises of lectures in future sessions. Those who were absent on this occasion missed what must rank as one of the most able and most useful lectures of the session. The discussion, in which several of the members took part, showed that the lecture had been followed very closely, and must have compensated the lecturer somewhat for the small attendance.

Our sixth meeting was held on March 1st, when Mr. J. Fraser lectured on the "Theory and Development of Central Battery Telegraphs." The attendance on this occasion was very good indeed, and the lecturer was followed with close attention. The discussion which followed was both useful and interesting.

SCOTLAND WEST CENTRE.

Once more we are indebted to Mr. Hetherington for the opening paper of the session. The meeting was held on the 4th February, and the few who gathered together experienced a fine treat. Mr. Hetherington's subject was "Telephone Transmission," and, naturally, he followed on his paper of last session, the one being sequel to the other. The treatment was partly theoretical, partly practical, and the two were welded into one harmonious whole.

The second meeting was held on the 25th February, the chair being taken by the Superintending Engineer. Mr. J. W. Woods, Assistant Engineer-in-Chief was present.

Mr. J. Richardson read a paper entitled "Some Considerations involved in the transfer of the National Telephone Company's System: (1) Accommodation for plant, (2) Layout of Exchanges, (3) Maintenance of local telephone systems."

The discussion was opened by the Chairman who dealt particularly with the maintenance question. Other speakers followed, and finally Mr. Woods gave a short address on the various points which had been raised.

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METROPOLITAN CENTRE.

The Metropolitan Centre meetings of January and February were occupied by Mr. A. W. Martin with a very excellent paper on "The Loading of Underground Circuits." Discussion, though necessarily restricted owing to the length of the paper, was of a high standard, Mr. S. A. Pollock's contribution thereto being rendered extremely useful and interesting by the use of lantern slides to illustrate his several points. The lecture will, it is hoped, be printed for general circulation to the members of the Institution; it certainly forms a most valuable contribution upon a theme of general interest concerning which much information is not available.

The evergreen subject of "The Training and Education of a Post Office Electrical Engineer" was treated with originality and human sympathy by Mr. A. W. Heaviside (late of Newcastle) on March 8th. The conclusions of the lecturer were vigorously applauded, and the discussion was animated and interesting.

SOCIAL NOTES.

METROPOLITAN SOUTH DISTRICT.

Members and friends of the staff of the Metropolitan South District held their annual social gathering on the 20th February last at Wandsworth Common on lines similar to those of previous occasions, the large rooms being decorated and transformed by the Committee and a bevy of willing helpers into a veritable fairyland.

Mr. A. Moir presided. Amongst the visitors present were Mr. A. J. Stubbs, Mr. C. T. Fleetwood, Mr. T. Harrison, Mr. R. McIlroy, Mr. T. F. Purves, and Mr. T. E. P. Stretche.

The programme was conveniently divided into four parts, concert and dance alternating.

The vocalists were Mesdames A. A. Little and Mary Tynan and Messrs. Alec Gamgee and S. Lees Bickerton. Violin solos were contributed by Mr. W. G. Southcombe, and recitations by Mr. J. Jesson French, whilst Messrs. J. Hillier and J. Lewis sustained the humorous section. The introduction of the Metso Orchestra with Mr. H. J. Bullard as conductor was a pleasant surprise to everyone present.

METROPOLITAN NORTH DISTRICT.

On Saturday, March 6th, the Hornsey Section (Metropolitan North District) Staff Dinner was held at the Finsbury Park Hotel. Mr. T. Lewis presided over a gathering of about 150 including representatives from other Sections, Districts and Departments. During the evening the Chairman made various presentations on behalf of the Staff to ex-Linemam G. Walters on his retirement after thirty-nine years' service. Mr. E. J. Eldridge (Assistant Superintending Engineer), and Messrs. N. Bathurst and H. C. Price testified to the ability and zealous industry which characterised Mr. Walters' term of service in the District, and several of his late colleagues contributed to a "send-off," which spoke eloquently of the respect and esteem in which he was held by all who were associated with his work. A very good musical programme completed a most successful evening.

VISITS TO WORKS, ETC.

NORTH-WESTERN CENTRE.

By the courtesy of the National Telephone Company, Limited, the members of the North-Western Centre visited the City Exchange, Manchester, on the 22nd and 23rd February.

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The Exchange, which it is expected to open on the 20th March, is being installed by the Western Electric Company, and the equipment is of the standard design.

The parties were conducted by the District Manager (Mr. Taylor), the Chief Electrician (Mr. Wallace), and the Clerk of the Works (Mr. Hughes), and to these gentlemen the thanks of the Institution are due for the care with which their self-imposed duties were performed.

METROPOLITAN CENTRE.

During the quarter visits have taken place as under:

January 4th.—Holloway Factory.

18th.—Stores Department, Mount Pleasant (second visit).

February 1st.—Lots Road Power Station.

Good attendances being secured in each instance. Efforts are being made to re-arrange the postponed visit to the Cable Ship and Submarine Depôt, and to meet the wishes of the large number of members who would otherwise be unable to attend a Saturday afternoon will be arranged for if possible.

CHESS CLUB NOTES.

THE Chess Club has proved very successful since the notes for the preceding issue were written, having won each of the six League matches contested. The result of the individual matches and the total score to date are shown in the following table

Engineering Department *versus*	Games.			Matches.			
	Played.	Won.	Lost.	Played.	Won.	Drawn.	Lost.
Local Government Board II.	10	6	4	6	6	—	—
India Stores Depôt . .	12	8	4				
Patent Office II . . .	12	8	4				
L.C.C. II	12	7	5				
G.P.O. Stores II . . .	12	8½	3½				
Paymaster-General . .	12	8	4				
Total for the whole season .	102	61	41	9	7	1	1

About 100 members and friends attended the Club's headquarters on February 2nd, when Mr. I. Gunsberg delivered an interesting lecture on the recent Lasker-Tarrasch match, and the lessons to be drawn from the now famous fourth game. The lecture was followed by simultaneous display on twenty boards, ten of which were taken by members of the G.P.O. (North) Chess Club. Most of the games were well contested, and as the result of nearly three hours' play Mr. Gunsberg won 12, drew 5, and lost 3. Mr. W. Harrison scored a win for the Engineering Department, and Messrs. Stattery, Stephenson, and Turner secured draws. Of the G.P.O. (N.) players Messrs. Liddell and Light won, and Messrs. Bunce and Jamieson drew.

Four members of the Club were included in the Post Office team which beat the United Banks in February by 26½ games to 23½, and of these Messrs. Turner, Bartholomew, and Smerdon were successful.

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A whist drive, the first social club gathering graced by the presence of ladies, was held on March 6th, at "Tiffin's," Cheapside, E.C. Despite the inclement weather, over 160 persons assembled to spend what proved to be a most enjoyable evening. Some valuable prizes were provided by the Committee, and two extra prizes were generously given by Messrs. Kempe and Stubbs. At the close of the evening Mrs. Noble kindly presented the prizes, and Mr. Noble, in a short speech, welcomed the action of the Committee in organising the drive. He pronounced the gathering a success, and expressed the hope that it would prove to be the forerunner of many. The warmth with which his remarks were applauded was evidence that all present shared the same hope, and determined the Committee to hold two whist drives each season—one in late autumn, the other in the spring. It should be added that the excellent arrangements made by the caterers, Messrs. Tiffin, conduced materially to the success of the evening.

The Annual Club Supper will be held early in April.

W. H. S.

BOOKS RECEIVED.

'Life of Sir Charles Tilston Bright,' by CHAS. BRIGHT, F.R.S.E. Archibald Constable & Co. 12*s.* 6*d.* net.

'The Telegraphist's Guide,' by BELL and WILSON. S. Rentell & Co. 2*s.* net.

'Telegraphy and Telephony,' by H. P. FEW (E. in C.O.). 'Questions and Solutions.' Ordinary grade papers 1904–8. 2*s.*

We regret that we are unable to deal with these books in this issue owing to want of space.

OCEAN CABLE TARIFFS.

INTERESTING contributions on this subject, which of late has occupied much space in the public press, appear in the March numbers of the 'Westminster Review' and the 'Fortnightly Review.' Both are from the pen of Mr. Charles Bright.

FOREIGN AND COLONIAL NOTES.

WE shall be pleased to receive communications of interest from readers abroad.

CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

ELECTRIC TRAIN STAFF FAULTS.

A RECENT number of the JOURNAL contained an extract from a railway periodical showing that a train on the Great Northern Railway of Ireland had been "held up" by a spider.

It may be interesting to know that whilst an informal chat was proceeding after our late Institution meeting it transpired that an identical stoppage occurred about eight years ago in the North of Ireland, and was very carefully investigated at the time by the late Mr. James Walby, who was satisfied that a bluebottle fly had caused it, having been caught between the contacts of the signalling key and crushed.

I should possibly explain that the Train Staff Instrument has an iron drum-head containing all the working parts, and that it is generally locked up for periods of about one month at a time. The drum-head has a series of iron discs which revolve when a staff is

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inserted, or withdrawn. It has openings on the underside to permit of this taking place, and through these the small creatures pass to shelter. Some time ago a lineman, on opening an instrument in County Cork, found a mouse's nest and young mice in it, filling the recess in which the battery press key is often kept. The "wee timorous beastie" was evidently not afraid of the revolving mechanism, but how it determined that it had just sufficient clearance I do not know.

A. T. KINSEY, A.S.E., Dublin.

STAFF CHANGES.

BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

PROMOTIONS.

District.	Name.	Appointment.	Previous Service.
E. in C.O.	Greene, T.	Clk., 3rd Cl.	Sr., Cir. Office, 1906.
E. in C.O.	Flanagan, W. J.	Clk., 3rd Cl.	Sr., Cir. Office, 1906.
E. in C.O.	Apted, P. F.	Clk., 3rd Cl.	S.C. and T., Redhill, 1902.

RETIREMENT.

E. in C.O.	Brighton, W. G.	Engr., 2nd Cl.	E.T. Co., 1866; P.O., 1870; Relay Clk., 1887; Engr., 2nd Cl., 1895.

TRANSFERS.

Name.	Rank.	District.	
		From.	To.
Cowie, F. E. W.	Engr., 2nd Cl.	Sc. W.	Sc. E.
Whillis, C.	Engr., 2nd Cl.	E. in C.O.	N.
Twells, W. E.	Engr., 2nd Cl.	E. in C.O.	N.M.
McMorrough, J.	Engr., 2nd Cl.	Met. S.	N.M.
Hill, J. G.	Engr., 2nd Cl.	E. in C.O.	S.M.
Giffin, A. E.	Engr., 2nd Cl.	Met. C.	S.M.
Gray, A.	Engr., 2nd Cl.	Met. S.	N.E.
Cheshire, F. W.	Engr., 2nd Cl.	N.	E. in C.O.
Stevenson, B. J.	Engr., 2nd Cl.	E. in C.O.	N. Wa.
Anson, B. O.	Engr., 2nd Cl.	E. in C.O.	N.E.
Tinsley, W. S.	Engr., 2nd Cl.	Met. N.	E. in C.O.
Wells, R. A.	Engr., 2nd Cl.	E. in C.O.	Met N.
McNicol, A. J.	Engr., 2nd Cl.	Met. S.	S. (R.E.)
Fulcher, H. W.	Engr., 2nd Cl.	E. L. and P.	E. in C.O.
Moller, O. P.	Sub-Engr.	E. in C.O.	Met. N.
Cowling, G.	Sub-Engr.	Met. N.	E. in C.O.
Hill, G. A. D.	Sub-Engr.	Met. C.	E. in C.O.
McCormack, W.	Sub-Engr.	N.M.	Met. C.
Gilbert, D. P.	Sub-Engr.	N. Wa.	E. in C.O.
Brodie, C. C.	Clk., 2nd Cl., Ldn.	Met. N.	Met. S.
Parish, G. J.	Clk., 2nd Cl., Ldn.	Met. S.	Met. N.
Starkey, E. A.	Clk., 3rd Cl., S.E.'s Office	S. (R.E.)	E.
Hansford, W.	Clk., 3rd Cl., S.E.'s Office	S.M.	S. Wa.
Clements, G. T.	Clk., 3rd Cl., S.E.'s Office	S. Wa.	S.M.
Martin, H. E.	Clk., 3rd Cl., S.E.'s Office	N.W.	Met. C.
Colman, W. A.	Clk., 3rd Cl., S.E.'s Office	S.M.	Met. N.

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The Mid-day Meal under the Lee of a Tarpaulin.

The Mid-day Meal in the Shelter Tent.

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HARVARD UNIVERSITY
DEPARTMENT OF ENGINEERING

THE
Post Office Electrical Engineers' Journal.

THE EARLY HISTORY OF WIRELESS TELEGRAPHY.

By J. E. Taylor, A.M.I.E.E.

(*Continued from p.* 6.)

Except the object to be attained there is little in common between the current-spreading and inductive systems of wireless telegraphy and the subsequent Hertzian wave methods. The line of demarcation is sharply defined both in details of the means used and principles of operation.

Basic Principles of Hertzian Methods.—Actual emission of energy, rather than mere expansion or swelling of an electro-magnetic energy system, is involved. There is an actual detachment of energy which acts independently of the source of emission and therefore operates under quite different limitations and laws. Expanding surfaces or shells of constant thickness involving laws of the square of the radial distance rather than expanding spheres or volumes involving the cube of the radius are concerned. The result of such a change of conditions on the attenuation of energy with distance from the source, apart from the obvious advantages of manipulation and control of the detached energy, will be apparent, and in this fact lies the main reason for the displacement of all the older systems by the method of emission of Hertzian waves, now known as radio-telegraphy.

Evolution of Method.—The system as a whole is a product of the physical study of high-tension electrical phenomena; of electro-static machines and induction coils rather than of currents and dynamo-electric machinery. Without the conception of electric displacement in its relation to the laws of electro-statics Maxwell would never, in all probability, have formulated his electro-magnetic theory of light, nor predicted the possibility of producing electro-magnetic waves of much slower periodicity than those constituting light.

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It was by the study of the spark phenomena accruing upon the discharge of Leyden jars and conducting surfaces of small electro-static capacity that Hertz was able to demonstrate the production and existence of the waves and to investigate their undulatory properties. Branly's radio-conductors, now popularly known as coherers, were discovered by the agency of electric sparks produced in the vicinity. Lodge's classical researches on the behaviour of oscillating discharges from Leyden jars and the production of waves on conducting wires aimed at the realisation of Maxwell's predictions, but had special reference to the theory of lightning conductors and lightning protection, and concerned electro-static phenomena in a pre-eminent degree. Through his familiarity with high-tension electrical discharges, though they mainly concerned effects in high vacua, Crookes was able in 1892 to discern and predict the application of Hertzian waves to wireless telegraphy. A demonstration of the possible utility of the coherer for this purpose when excited by electric sparks was given by the writer at about the same time, an electro-static machine being used for transmitting. Marconi's attention appears to have been directed to the subject in 1895 as a result of instruction in electric wave theory by Prof. Righi, himself a foremost investigator in this branch of physics, and well accustomed to high-tension electric discharges. The evolution of radio-telegraphy was undoubtedly a result of investigations in high-tension electrical effects, having for their object the fuller comprehension of the underlying laws and the advancement of physical knowledge. Familiarity with and a due understanding of electro-static phenomena was very much the exception rather than the rule in the electrical profession at this time, hence the attitude of disparagement very frequently assumed, but which arose mainly from lack of knowledge and insight.

CONTEMPORARY STANDARD OF KNOWLEDGE.—For any really useful estimate of the degree of novelty involved in the invention or discovery of a new method or process whereby practical use is made of the results of scientific investigation, it is desirable to consider not only the standard of scientific and abstract knowledge contemporary with the discovery, but the standard of knowledge of the practical engineer into whose realm the discovery is introduced; the more so because the scientist is prone to appraise from the point of view of its value as an addition to knowledge, while the practical engineer is much more concerned with the commercial value in regard to its applications. The latter is also, without doubt, the ruling factor in the popular estimate of credit due to an inventor. In view, however, of the far-reaching consequences of additions made to scientific knowledge, the intrinsic value in this respect must be held to outweigh any commercial worth in an invention. Marconi's

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early methods certainly constituted a scientific achievement of no mean order, but they can hardly be said to have involved hitherto unknown principles in physics. The ground-work had already been laid by slow and laborious investigations by men who did not concern themselves with commercial applications. There can be no doubt, however, that his proposals and demonstrations widened the field of vision of the scientists, and fully awakened them to the practical importance of the principles previously discovered. On the other hand, so far as the prevalent standard of electrical knowledge in the electrical engineering profession was concerned, it must be insisted that electrostatics held no place. Electrostatic theory was generally disregarded, if not neglected. Though it was an asset of the educational training of the electrical engineer, his attention was so wholly directed to the development of electrical machinery and the applications of electric currents that his knowledge of advances in pure electrical theory was extremely limited. Indeed, his conceptions of electrostatic fields, despite familiarity with the idea of magnetic fields and lines of force, were practically *nil*. Tesla's demonstrations in 1892 had awakened some interest in high-tension phenomena, but it was of a superficial and transient nature, whilst having small educational value owing largely to the unconvincing explanations put forward to account for the effects produced. In other words, electrostatics had been relegated to a "back seat," and few, even of the foremost scientific men of the day, really had anything more than a scant insight of the nature of, and laws governing, electrostatic fields, or appreciated the inner meaning of the work of Hertz. To substantiate this statement it is only necessary to mention one or two of the wholly inadequate and unsound conceptions which were promulgated from men of distinction in science and engineering soon after Marconi's achievements had begun to attract attention. Thus, distinctions were freely drawn between electrostatic waves and electro-magnetic waves; electro-magnetic induction was often held to be an effect of electro-magnetic waves, whilst electrostatic induction constituted, or was produced by, electrostatic waves. Then electric waves were held to be synonymous with changing electrostatic induction or with electro-magnetic induction as fancy dictated, in spite of the widely different laws connecting distance with effect produced. They also became mixed up with X rays, there being, in some cases, a tendency to regard the radiation of waves as an effect proceeding directly from the spark itself, as evidenced by proposals to put a reflecting surface behind the spark gap in order that radiation in one direction only might be produced. Many other ideas equally grotesque in their inadequacy might be quoted. Indeed, the idea of wave formation from the electrostatic field of force about the

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antenna or the simple Hertzian oscillator itself was slow to present itself, in spite of the Hertzian diagrams which had been published six or seven years previously. In fact, these diagrams remained almost in oblivion until applied to the explanation of Hertz wave formation in wireless telegraphy, first, it is believed, by the writer in 1897, and again in a modified manner in 1899 in articles published in the London 'Electrical Review,' after which they quickly became appreciated more generally. To mention only one more of the many unsound conceptions current at the time of Marconi's early work, there was great diversity of opinion as to whether the antenna was not merely an agent whereby the waves generated by the Righi form of oscillator (used as a spark gap) were enabled to produce inductive effects at a distance, the view sometimes held being that the antenna was thrown into ripples or short electric oscillations of a length determined solely by the size and character of the Righi oscillator. Professor Righi himself was inclined at the outset to infer that the results obtained by Marconi were made possible by the use of the Righi oscillator. It was quickly demonstrated, however, that its function was merely that of discharging electrodes allowing the charged antenna to discharge itself to earth with sufficient suddenness to produce oscillations of a period determined by the electrical constants of the antenna and not of the Righi oscillator. All this, of course, tends to show the general haziness which obscured the whole subject at this early date.

Some idea of the nature of Marconi's views at this stage may be gathered from a perusal of his first published patent specification, though it should be stated that he did not publicly expound these views, nor claim for them any other use than that of rough working hypotheses. In the first place he was inclined to regard the principle of operation of the earthed elevated capacity system as essentially different from his reflector system, in which no earth connection was used and a simple form of oscillator served to radiate waves. In the former case transmission was supposed to be effected by electrical vibrations set up in the ground and propagated through the ground. He was wont to adduce as arguments in support of these views—

(*a*) That the waves, if any, produced could not be reflected as could Hertzian waves.

(*b*) That hills and mountains failed to screen off the effect.

(*c*) That the distance at which signals could be detected increased greatly with increased height of the elevated capacity.

With regard to the last argument the idea was that a greater shock would be imparted to the earth by the discharge of a highly elevated capacity than by one less highly elevated.

It has sometimes been noticed that no reference is made to

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elevated *wires* in Marconi's early patent specification. The reason for this is that Marconi had in mind elevated capacity areas, such as plates, drums, or cylinders and wire netting. The first use of simple elevated wires occurred in trials carried out, with the assistance of officials of the British Post Office, on Salisbury Plain in September and October, 1896, the trial of a simple wire being made at the instance of the late Mr. John Chapman, who foresaw difficulties in the way of using the proposed forms of highly elevated capacity areas in exposed positions during stormy weather, especially on shipboard.

CONFLICT OF THEORY AND PRACTICE.—Marconi never laid stress on theories, always preferring to be guided solely by experimental results, and his successes were all attained by sheer application and persistence, combined with aptitude for experiment and memory for detail. A little theory and a lot of practice, together with unbounded enthusiasm, marked his progress from the beginning. With a few prominent exceptions advances in radio-telegraphy have been attained, first by practical results, followed afterwards by theoretical explanation. Where theory has preceded practice it has frequently proved inaccurate, as in the matter of the effect of earth curvature, when, reasoning on the basis of rectilinear propagation, the prophets foretold a quick limit to the radius of communication from this cause. Again, when this was refuted by experiment, these same prophets ventured again to assert that even though it were possible to communicate great distances by establishing powerful stations, the overwhelming radiation produced must necessarily be fatal to the use of short range and moderate range installations, and that the proper function of radio-telegraphy as a means of communication for ships at sea would be totally destroyed. Tuning they regarded as existing more in the imagination than in reality, or at the most as a mitigation, but by no means a cure for the evil. As a matter of fact, the operation of high-power stations for transatlantic communication has unfolded a degree of immunity from interference between stations of widely different wave lengths which the most sanguine had hardly hoped for. On the other hand, a faculty for grasping the principles underlying a series of results can hardly be said to have been Marconi's *forte*. In the matter of the theory of coupling resonant circuits there can be little doubt that practical use of diminished coupling was made by Marconi in some of his earliest tuning tests; indeed, this is clearly shown by the diagrams published by him some time previous to Wien's theoretical disquisitions on the matter, but as a *principle* underlying the results he obtained there is nothing to indicate that the coupling idea was grasped, nor the utility of diminished coupling (obtained by the use of detached tuning inductance spirals in the antenna) specially appreciated by him.

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EARLY POST OFFICE ASSOCIATION WITH MARCONI.—In May, 1896, Marconi wrote to Sir William Preece, then Engineer-in-Chief to the British Post Office, outlining some of the results he had obtained in wireless telegraphy by a new method, and by means of which he claimed that it would be possible to signal at least twenty miles and overcome obstructions, such as hills or other obstacles, if desired. In reply he was told that facilities would be afforded him for demonstrating the utility of his apparatus if he would bring it to the Post Office. The offer was accepted and Marconi brought over from Italy a number of home-made and somewhat crude appliances for the production and detection of Hertzian waves, in which a modified and very sensitive form of Branly's tube was used as the means of picking up the waves and operating a telegraphic receiving instrument.

NOVELTY OF THE MARCONI APPLIANCES.—None of the individual appliances can be said to have been novel in themselves, but the methods of utilising them embodied several features of novelty. In other words, the receiver was an improved Hertzian wave detector, whilst the sending apparatus did not differ very materially from known forms of Hertzian oscillator; but the plan of connecting each of these in a circuit containing an elevated capacity area and utilising a connection to earth embodied the primary elements of success for radio-telegraphy. The method of isolating the oscillation or high-frequency circuit or circuits, in which the coherer was connected, from the auxiliary circuit and appliances (battery, relay, etc.) by means of small choking coils also appealed to the writer as a novelty in Hertzian detectors, and was undoubtedly correct in principle. Up to this time there does not appear to have been any published record of serious attempts to utilise Hertz waves for wireless telegraphy, though it shortly transpired that Sir Henry Jackson had been engaged on the subject in the British Navy during the previous year (1895). Popoff, in Russia, had also struck the idea pretty closely, while Sir William Crookes' surmises have already been mentioned. It also appears that Dr. Alexander Muirhead had done a little work in the same direction. In no case, however, can it apparently be stated definitely that any results had been published, and it is to Marconi that the credit of pushing the application to a practical issue must be awarded.

As already mentioned, the first proposals of Marconi involved an alternative method of communication, using plane parabolic copper reflectors together with his modified transmitters and receivers, after the manner of the original Hertz methods—that is, without any earth connection or elevated capacity. In the reflector arrangement the radiator or transmitter and the conducting strips or "wings" attached to the coherer were always carefully tuned to one another

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by adjustment of the length of the wings. Tests of the receiver when adjusted in the receiving reflector certainly showed that Marconi had succeeded in constructing a coherer which, for sensibility combined with reliability, considerably surpassed anything that had been done previously. It is within the writer's experience of the receiver thus arranged that it would give perfect reproduction of Morse signals when using a small trembler bell excited by one small dry cell at a distance of fifteen or twenty feet, coppers strips or wings one foot long being attached to the bell terminals. The plane parabolic reflector which embraced the receiver was one of a pair constructed in the Post Office workshops, and had an aperture of six feet and a width of four feet. That the reflector method involved the use of Hertzian waves was not, of course, open to question, but it was the widely different character of the results obtained with the elevated capacity arrangement, together with its power of bridging obstacles, that led Marconi to suspect a different type of electrical operation and a different principle in the latter case.

(To be continued.)

Erratum.—In the last number an uncorrected error appears on page 3, line 5. For " Loch Tay " read " Loch Ness."—J. E. T.

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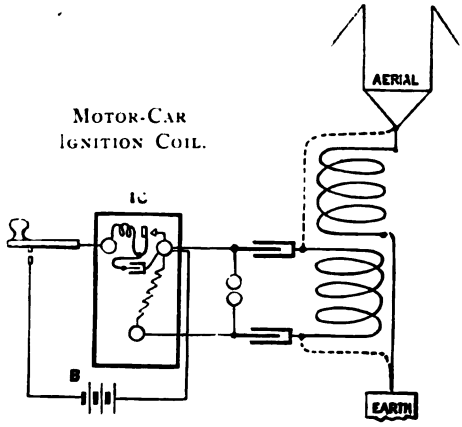
RADIO-TELEGRAPHIC APPARATUS FOR SHORT DISTANCE TRANSMISSION.

By A. C. Booth.

In conjunction with Mr. J. E. Taylor the writer recently carried out some experiments between the Post Office radio-telegraph stations at Skegness and Hunstanton, with a view to obtaining a simple and cheap yet satisfactory means of transmission for short distances, such as is required between the mainland and small islands around the British coast. In such cases there is not much telegraphic traffic, and the provision of a submarine cable is prohibited on account of the costly and frequent repairs rendered necessary by the action of tide races in chafing away the protective sheathing against the rocks.

The following is a brief outline of a portion of the series of tests made.



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In the experiments it was arranged that the height of the aërial wire should not exceed 80 feet. Two $\frac{3}{18}$ stranded copper wires were joined together at the base, but separated by about 4 feet with wooden spreaders till they reached the required height of 80 feet; they were then extended outward and downward in opposite directions for 70 feet. The insulators were 6-inch ebonite links. The earth-plate was the ordinary earth-plate of the station, being a fan of 6-inch copper strips buried about two feet below the surface of the earth.

An ordinary high-speed trembler ignition coil, as used on present-day motor cars, and costing about 25s., was supplied with current

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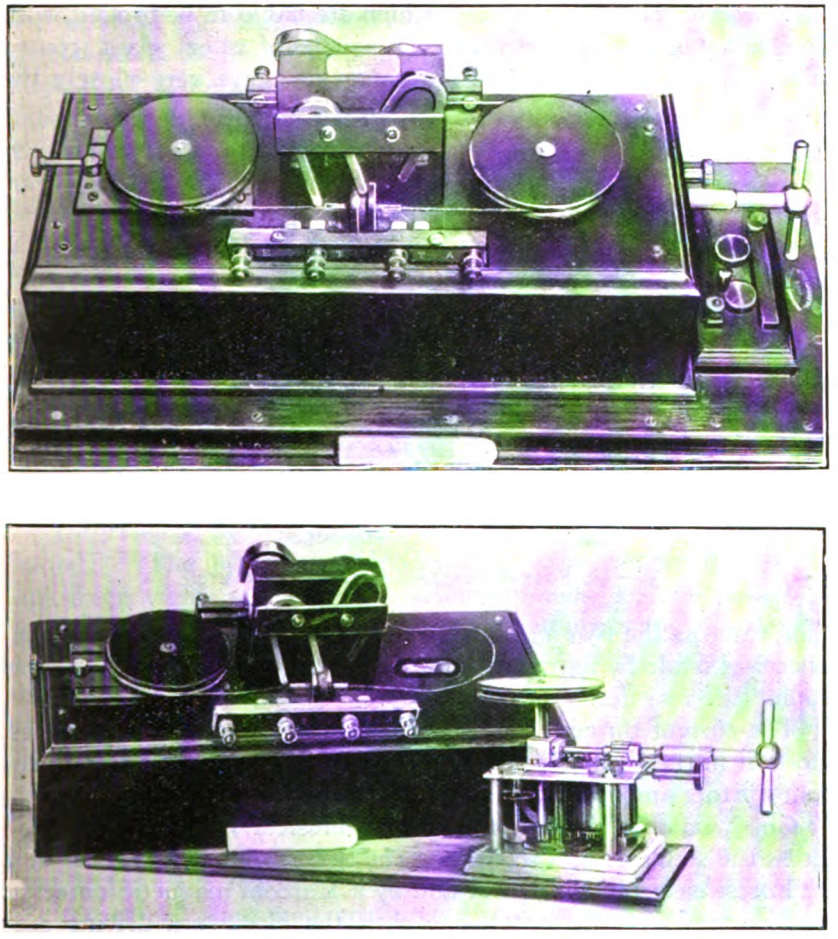
from three small secondary cells. The high tension side was joined to a spark gap consisting of two brass balls, 1 inch in diameter, separated $\frac{1}{32}$ of an inch. Each side of the spark gap was connected to a Leyden jar of ·003 microfarads capacity, and the other coatings of the two jars were connected together through an inductance of



2.—MARCONI MAGNETIC DETECTOR.

four turns of stranded copper wire wound on a wooden box, approximately 12 inches square, giving a wave length of about 800 feet.

Four turns of similar wire wound on another box of the same size were placed in the aërial circuit. The boxes were arranged to be movable so that the degree of coupling could be varied.

An ordinary Morse telegraph key without special contacts was used for signalling.

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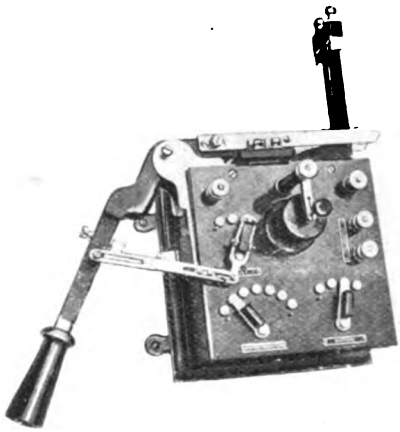
A sketch of the transmission connections is given in **1.**

In another experiment the separate aërial inductance was omitted and a direct connection made from the two ends of the jar circuit inductance to the aërial and earth respectively. These connections are shown dotted in the figure.

Subsequently experiments were made with enclosed glass plate condensers in place of the jars, which are liable to be broken, with the result that three plates six inches square of 21 oz. glass, coated on both sides with tin foil five inches square, gave very closely the



3.—De Forest Electrolytic Receiver, etc.

same value as the two jars in series, viz. ·0015 mf.; and the inductance was made by four turns of $\frac{7}{22}$ electric light wire with the turns wound side by side.

The current through the primary of the coil was 1·5 to 2 ampères, and that in the aërial, as shown by a Duddell thermo-ammeter, was from 1·7 to 2 ampères.

Good, reliable signals of almost a musical note were received across the sixteen miles separating the two stations by means of a De Forest electrolytic receiver and by a Marconi magnetic detector.

Two views of the latter, one with the clockwork driving gear exposed, are shown in **2**, and a view of the former with the aërial switch, potentiometer, etc., is shown in **3**.

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THE PARIS FIRE—AND AFTER.

By D. H. KENNEDY, A.M.I.E.E.

WITH that love of symmetry which is so evident to the visitor, the Parisians have arranged their telephone exchange system so that it consists of one large central exchange, surrounded by six others, spaced so as to almost form a hexagon. The Central Exchange, known as "Gutenberg," had plant of the magneto type for 28,000 subscribers, and in addition the building accommodated the Trunk Exchange. I visited this building in August, 1907, and I remember very clearly two impressions made on my mind: (1) The great magnitude and value of the plant concentrated in one building—over 17,000 subscribers' lines were at work; and (2) one could not escape a feeling of regret that so modern and enterprising a city as Paris should still be using apparatus of a type which had been discarded so largely elsewhere.

On the evening of Sunday, September 20th, 1908, practically the whole of this huge plant was destroyed by fire in a few hours. The fire started at 7 o'clock in the evening, at a time when there were only forty operators on duty—on ordinary days the staff reaches 1400.

Interviewed by 'Le Journal,' after her escape, one of the operators stated: "The building is divided into four distinct parts: The first floor, which serves for the suburban lines, and provincial and foreign trunk lines; second floor, serving numbers 10,000 to 20,000; third floor, numbers 20,000 to 30,000; and the fourth floor 30,000 to 40,000. It was exactly 7.15," she said, "when suddenly the odour of burning gutta-percha attracted the attention of the chief operator on the fourth floor. A rapid inspection showed that the cables were cut off, or else a short circuit had been produced. We were instructed to cease work and leave the building as quickly as possible."

No fireman was kept on the building, but help arrived immediately from the adjoining station in the Rue Jean Jacques Rousseau. The firemen attempted to enter the basement, where the fire appears to have originated, but in spite of their masks they were unable to do so; and this can be readily understood when it is stated that half a million yards of paraffined jumper wire was aflame on the distribution frame. Unfortunately the cable shafts leading from the basement to the first, second, third and fourth floors were not blocked. They therefore formed chimneys up which the flames rushed. On each floor, except the first, the shafts communicated with the false floors of the switchrooms. It was due to this fact that one hour after the fire began the first and second floors were burning, and an hour later the third floor was also ablaze.

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On the first storey there was no false floor, and at this point the firemen were able to save the provincial and suburban plant.

It was hoped at one time that the new C.B. multiple for 10,000 subscribers situated on the fourth floor might be saved, but at 11 o'clock this floor was on fire. The damage was, however, limited, owing to the frames being of modern construction, with iron separating partitions, and here the water did more harm than the fire. As evidence of the great heat which was generated it may be stated that the cast iron pillars supporting the fourth floor were twisted and broken, endangering the safety of the whole building.

The third and fourth floors had, however, recently been strengthened, and this, in combination with the fact that the building was of fireproof construction, led to the preservation of the structure. At 2 o'clock on the following morning the fire had been got under control, but everything within the walls was destroyed, and immediate steps had to be taken to prop up the floors.

The immediate consequence of the fire was the throwing out of service of 18,000 subscribers' lines (out of a total of 43,000 in Paris); 10,000 junction lines and 450 trunk lines, together with the distribution frame connecting the cross-town junctions between the other offices. It can thus easily be realised that on the following day Paris was thrown back into the pre-telephone age, and business men felt that the nation had sustained a serious disaster.

The re-establishment of the service was undertaken with commendable promptitude. Beginning with the trunk lines, four London circuits and four Brussels circuits were connected to the Bourse on the afternoon of September 21st. On September 22nd seventy-four circuits were connected with suburban exchanges, and on September 30th 416 trunk circuits had been temporarily re-established. Several floors of an adjoining building were rented, and on October 1st the work of repairing and installing the trunk switches which had been preserved from the fire was commenced there. The problem of restoring communication for the 18,000 interrupted subscribers was, of course, a much more difficult one. It was only possible to connect a few of them through to the suburban exchanges. The immediate construction of a temporary building was decided upon. The place chosen was the Rue Gutenberg, a passage which separated the burnt-out telephone office from the Post Office, and which had been used for the loading of mail vans. In this passage a temporary building of brick and iron covered with zinc and glass was constructed. Fortunately the materials of the last Automobile Exhibition in the Invalides Square were available, and these were utilised. Plans were prepared by the distinguished architect, Monsieur Binet, and a building, consisting of a single hall 77 yards long and 32 feet 6 inches wide, was constructed. As it filled the entire space between

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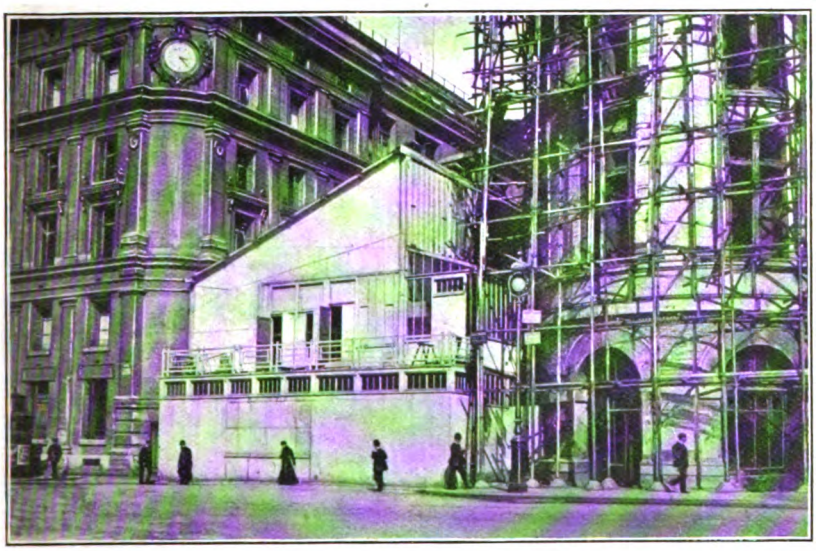
the adjoining buildings, lighting had to be arranged from the top, and the internal arrangement consisted of a ground floor and two overhead galleries.

1 shows one end of the temporary building viewed from the Rue de Louvre. The building on the left with the clock is the Post Office, and the building on the right, surrounded by scaffolding, is the burnt-out exchange building.

2 and **3** are views of the galleries and ground floor respectively of the temporary building, photographed after the installation of the switchboards.

It was arranged to instal in this building two multiple switchboards, each for 10,000 subscribers, the incoming positions only



1.—Temporary Gutenberg Exchange.

being provided with multiple jacks, and each outgoing section being equipped for 100 subscribers. These switchboards worked with C.B. signalling arrangements, the overhead gallery being reserved for the "A" positions and the hall beneath for the "B" positions, intermediate positions, distributing frame, and relay racks.

The work of constructing the temporary building was commenced on September 23rd, and it was ready for occupation on October 12th. Definite orders for the two multiple switchboards were given on September 26th and 27th—one to the Thomson-Houston Co. and the other to Messrs. Aboilard and Co., the French representatives of the Western Electric Co. The Thomson-Houston Co. were to use the material which had already been prepared for the conversion

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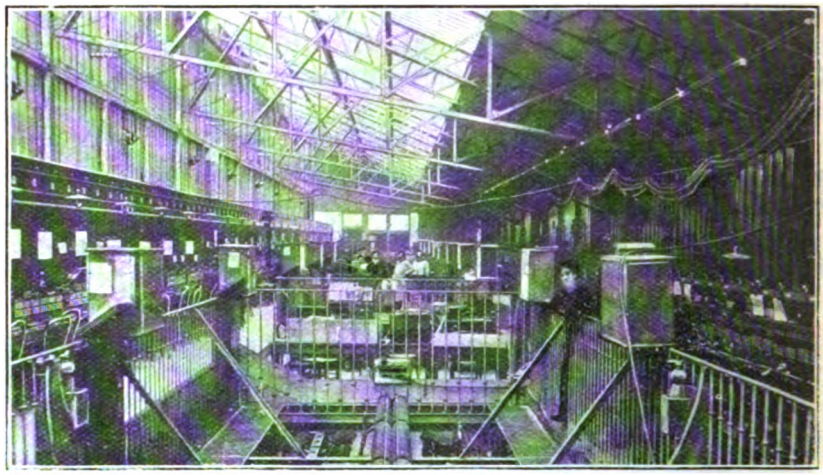
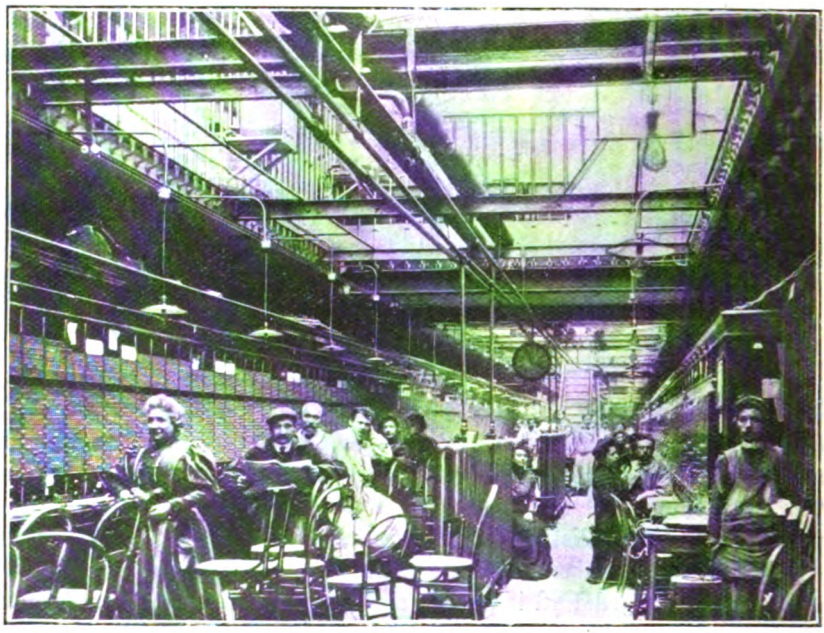
to central battery working of three other exchanges. The company undertook to finish their portion of the work in two and a half



2.—Temporary Exchange—Galleries.



3.—Temporary Exchange—Ground Floor.

months under a penalty of heavy fines for delay. Messrs. Aboilard and Co. were to construct specially, "B" sections of the latest

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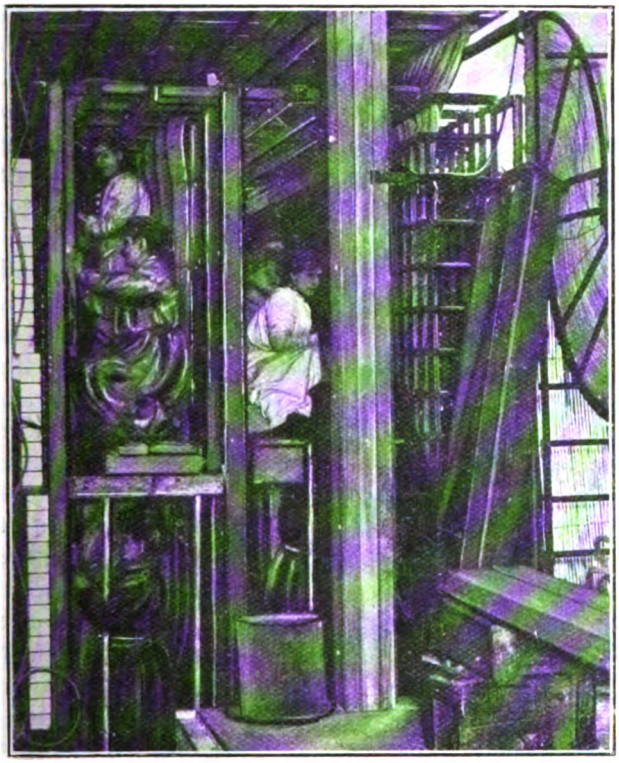
pattern, without multiple, whilst they were to receive from America answering sections entirely equipped for use. The installation was to be finished within a period of two months, with heavy fines in case of delay.

On November 5th the Thomson-Houston Co. had connected the junction lines and 1200 subscribers' lines. From this date these subscribers could avail themselves of the outgoing service, but could not be called up. The other subscribers served by this board were



4.—Temporary Exchange—Wiring Relay Racks.

successively connected through during the month of November. The incoming service was provided for them in the last week of November.

On October 29th Messrs. Aboilard and Co. had fitted 116 outgoing positions, and on November 2nd they received from America the intermediate distributing frame and the relay rack, and on November 7th the incoming sections. On December 5th the installation of this section of the multiple switchboard was finished, and the subscribers had been connected with it.

Only those who have been concerned in the erection of large ex-

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changes can fully appreciate the stupendous nature of the task undertaken by these firms ; more especially is this the case with regard to the Western Electric Company, seeing that they had to make arrangements for complete construction and for carriage from the other side of the Atlantic, and the successful completion of the undertaking must be regarded as a noteworthy achievement in the history of telephone engineering.

Some idea of the dimensions of the plant can be obtained by inspecting **2** and **3**. The switchboard on the left hand in each view has been installed by the Thomson-Houston Co., and that on the right hand by Messrs. Aboilard and Co. The latter firm employed 150 men and women for two months, and in view of the national character of the emergency, they were permitted to work without paying special regard to the laws usually governing such employment. Both men and women worked long hours, and were paid at double and treble rates, with bonuses for special achievements. **4** and **5** are interesting, as showing the extent to which the services of women were utilised, and the way in which they were crowded on to the work, so as to defeat, as far as possible, the arch enemy —Time. It is stated that the employees displayed the greatest interest in the rapid progress of the work, and that when cables or other necessaries failed to arrive the chief officials found much difficulty in inducing the workers to take even a little rest ; in many cases they worked fourteen hours per day.

5.—Temporary Exchange—Wiring Keyboards.

I paid a second visit to the Gutenberg Exchange in April, 1909, and was enabled to inspect the burnt-out building, and also the temporary building which has been constructed in such a wonderfully short time. Again I was impressed with the magnitude of the work carried out by my French colleagues, and on this occasion the sight of the familiar C.B. apparatus led me to remark that, in spite of the 20,000,000 francs burnt up by the fire, it is probable that the accelerated introduction of C.B. working at Paris will bring about a gain which will more than outweigh the Gutenberg loss.

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The French engineers, both of the Administration and of the companies referred to, are alike to be congratulated on having met so difficult a situation with so much energy and intelligence, and on having achieved a very wonderful result in so short a time.

The transformation to C.B. working has now been completed, and from May 1st all the Gutenberg subscribers are experiencing the benefits of a modern system.

A point of special importance is that, in spite of the feverish haste at which the work has been done, and the fact that the switchboards were taken over without time being spent on any special tests, the number of faults has been exceedingly small.

After such an event as the Paris fire, it is natural for the engineer to ask, How did it all come about? Where did the protective measures fail? and What lessons can be learnt from this event for use in dealing with future possibilities?

Gutenberg has been the subject of long discussions in the Chamber of Deputies, but no definite conclusions have been arrived at. The following points, however, may be set down for consideration. There have been frequent fires in Paris exchanges, but in all previous cases they have fortunately been extinguished. In each case it has been found that the cause was a strong current coming from outside, *i. e.* similar to the case of the Bank Exchange in London.

Monsieur George Berry (I quote the official report of the Chamber of Deputies) said: ". . . the same kind of insulation was used for the old 30 volt as for the new system with 80 volts, and there was no employee on duty in the basement from 6 p.m. to 9 p.m. daily; the night watchman who came at 9 o'clock knew nothing about electricity . . . there were no oil lamps in case of failure of the electric light . . . there were no safety stairs . . ."

Monsieur Simyan, Under-Secretary of State for Posts and Telegraphs, regretted the terrible calamity, and said "everything possible was being done to remedy it. The fire broke out in the main frame in the basement . . . a workman found the fire. . . . He saw smoke on the seventh shelf of the main frame and threw sand on it, and he afterwards lifted some of the paraffined wires, when a flame a mètre long burst out. The men returned, but could not stop the fire. . . . A Commission is inquiring into the cause of the fire, but our technical experts affirm that the fire did not arise from contact with electric light wires outside. . . . There are fuses in the exchange apparatus, there are also fuses at the subscribers' offices, but there are none on the main frame in Paris. There are, however, at Grenoble, where we have had a fire, which was caused by contact with a power circuit, although there was flameproof wire with fuses on the main frame. . . . It is nearly certain that the

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Paris fire was not caused by installation wires or power circuits. The paraffined wire will carry 60 ampères and the multiple 10 ampères, although our currents do not exceed 4 ampères. . . . Flameproof wire is not a certain protection, as is proved by Grenoble, Antwerp, and Brussels."

The figures quoted by M. Simyan as being the carrying capacity of the paraffined wire are obviously incorrect.

The main frame referred to was not only without fuses, but it was equally destitute of protectors and heat coils. It may be added that, in order to increase the efficiency of the calling current, there was but little resistance in the circuit at the point of departure, and the subscribers' bells were old 200 ohm vibrating bells, transformed for use with alternating current.

It seems a pity to have to state that, except for the substitution of flameproof wire for paraffined wire, the same conditions prevail in connection with the temporary Gutenberg. The main frame is utilised merely as a connecting-point for the external and internal wires, and is unprovided with protective apparatus.

If the conclusions of the Commission of Inquiry are ultimately made public they will assuredly be read with great interest by telephone engineers. Meanwhile, it has occurred to me that it may be useful in concluding this article to set down the measures in connection with fire prevention which, at the present time, are regarded as desirable in connection with large exchanges.

(1) *Measures to Prevent Outbreak of Fire.*

(*a*) Limitation of voltages to low values.

(*b*) Provision of conductors of suitable diameter for current density.

(*c*) Efficient protection of main frames (heat coils, fuses, and lightning protectors).

(*d*) Use of efficient flameproof wire.

(*e*) Interposition of resistances in circuits to limit values of outgoing currents.

(2) *Measures to Prevent the Spread of Fire.*

(*a*) Use of uralite under flameproof jumpers.

(*b*) Fireproof sections with metal separating shelves.

(*c*) Vertical and horizontal channels blocked at intervals to prevent through draughts.

(*d*) Fireproof building with steel bulk-head doors for isolating sections of the building.

(*e*) Use of wired glass for windows and partitions.

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(3) *Measures for Fire Extinction.*

(*a*) A trained fireman in constant attendance, who is technically acquainted with the building and plant.

(*b*) Male employees trained to act as a fire brigade.

(*c*) An efficient system of fire alarms.

(*d*) Asbestos cloths, a yard square, in red tin cases, should be provided on a liberal scale and in conspicuous positions, with instructions as to their use for smothering flames.

(*e*) Ample provision of sand, with instructions as to its use in preference to water. This should be in buckets, not too large, and there should be not less than six at any given point. Such buckets should be numbered conspicuously so that the absence of one will be at once evident.

(*f*) Small chemical *extincteurs* may be provided, or small hand pumps for use only in extreme emergency.

(*g*) A high-pressure fire main of at least three inches diameter, with hydrants fixed at points where they can be safely operated without danger to life. A nozzle and a long length of hose should always be connected, and the hose should be doubled back on itself so that it would only be necessary to turn the wheel, take down the nozzle and run to the fire. The hose should unwind automatically, assisted by the pressure of the water.

(*h*) With a view to preventing loss of human life, regular fire drills of the operating staff should take place.

(*i*) All doors should open outwards, and all doors and corridors and stairways should be of ample width and should be kept clear of obstructions. For high buildings iron emergency outside stairs should be provided.

After having given due credit to the French Administration for the great effort it has made, perhaps I may be permitted to express the hope that, for the sake of the operating staff, they will proceed quickly with the greater task of installing a new, and let us hope, a more permanent Gutenberg. The space in the temporary building is so restricted on the ground floor that the distance between key-boards is only about nine and a half feet, and in hot weather it is certain the conditions will not be of a very healthy nature.

The fire last year caused the recall of the French representatives from the first International Telegraph and Telephone Conference at Budapest. The French Administration have been good enough to arrange for the second Conference to be held in Paris in 1910. Is it possible that they have determined to give to their colleagues another gigantic surprise by inviting them then to view a rehabilitated Central Exchange?

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TRANSFORMERS IN SUPERIMPOSED TELEPHONE CIRCUITS.

By J. G. HILL.

THE Post Office has a large and ever-growing number of transformers in use in connection with systems of superimposing, and as there are some facts relating to the electrical effects, advantages, and limitations of this apparatus which are not to be found in text-books, the moment seems to be opportune for an article on the subject.

A convenient way of dealing with the matter will be to give an explanatory diagram of a superimposed system, and to make a study of any features in it which appear to be sufficiently important or interesting to warrant that course. As is well known, the Post Office system of superimposing is that shown in the accompanying figure, and the object of this article is to consider the advantages and disadvantages of that system, both from the technical and economic points of view.

GENERAL PROPERTIES OF TRANSFORMERS.—Transformers play an important part in superimposing, and it is therefore desirable as a first step to describe their general properties. Those with which we are concerned consist essentially of an iron core, over which two or more separate coils are wound according to the special requirements of the service. Consider the simplest case, where two coils are wound on the same iron core. If an alternating current circulates in one of them, called the primary coil, the rise and fall of that current will cause magnetic lines of force to cut the conductors of the other, which is called the secondary coil, and thereby to induce a voltage in it. The magnitude of this voltage will be proportional to the ratio of the number of turns of wire in the two coils; thus, if the secondary coil has twice as many turns as the primary it will have twice the voltage induced in it. The electrical *energy* in the two coils will, however, be the same in ideal conditions, *i. e.* calling the current and voltage in the primary coil c and v respectively, and that in the secondary coil c_1 and v_1, we have the equality of energy $c\ v = c_1\ v_1$. This, however, assumes that there are no losses of energy, but in practice such favourable conditions do not exist, and the losses may be summarised as follows:

LOSSES IN TRANSFORMERS.—(1) Dissipation of energy by eddy or Foucault currents, which are induced in the iron cores by the varying currents in the coils. These losses are proportional to the square of the frequency of the alternating current, and also to the square of the magnetic density.

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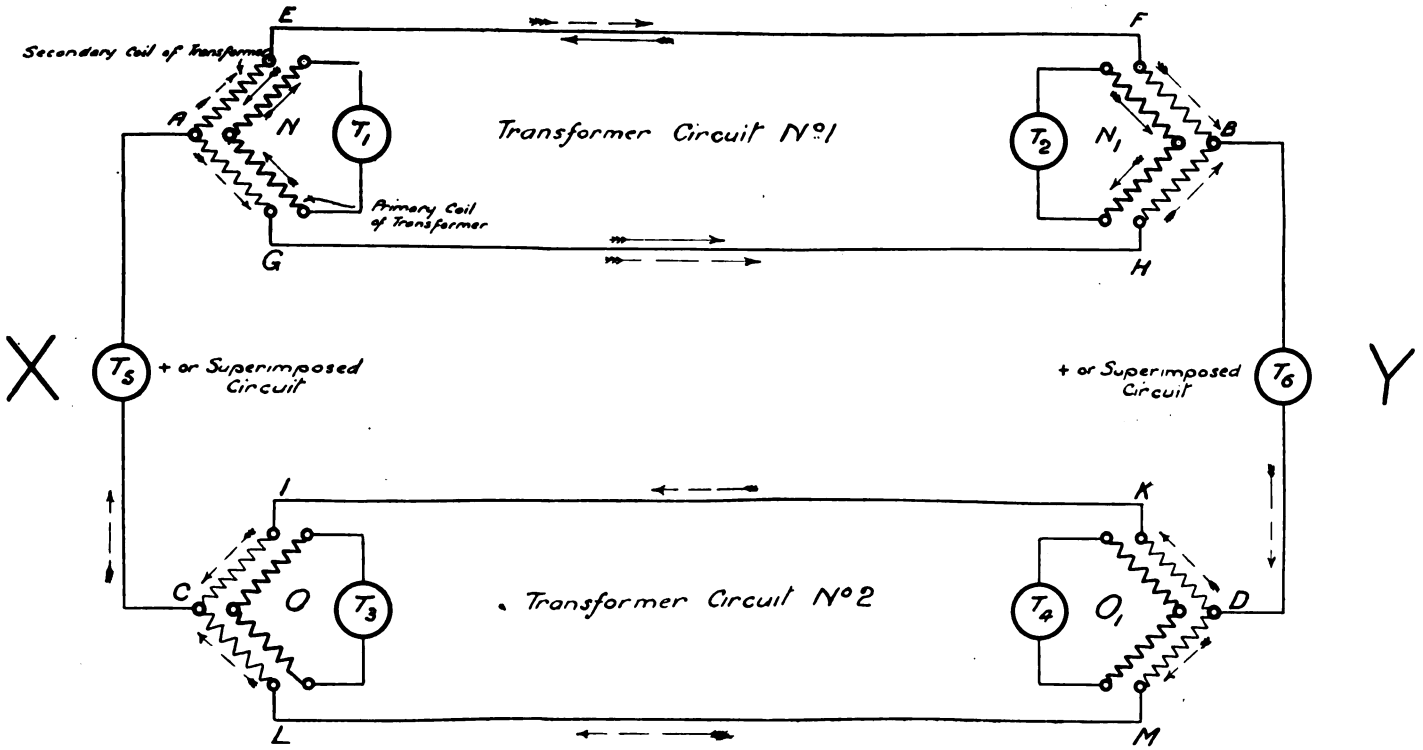
TRUNK TELEPHONE SUPERIMPOSED SYSTEM

Path of current in one direction round the + circuit.

Path of current in one direction round transformer circuit.



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(2) Loss of magnetic energy in the iron by hysteresis, which is analogous to mechanical friction and causes the magnetic effect to lag behind its cause. The loss is directly proportional in ordinary iron to the frequency and approximately to the 1·6th power of the magnetic induction.

(3) Losses of energy in the conductors (*a*) through eddy currents, and (*b*) through ohmic resistance. The loss due to (*a*) is proportional to the square of the frequency, and that due to (*b*) to the square of the current strength.

All these losses result in energy being frittered away into heat.

(4) Magnetic leakage, *i.e.* lines of force linking with one coil but not the other.

This is largely a matter of the correct arrangement of the relative parts of the windings and cores.

How to Minimise the Losses.—To minimise the loss due to (1) the cores are often made of varnished soft iron wire. The losses due to (2) can be minimised by the use of the best soft iron, but those due to (3) are inseparable from resistance and the mass of the conductor and cannot be eliminated.

Large commercial transformers can be made with an efficiency of 95 per cent. or more, but it is difficult to make small transformers so efficient.

Transformers for Trunk Telephone Circuits.—The transformers used for trunk telephone circuits should be efficient for both ringing and speaking, but the combined requirements involve a wide range of frequency and voltage which it is difficult to provide for. The frequency required for ringing is only about 16 per second, whilst the harmonics of speech may reach 3000 per second. The voltage for ringing is, say, 75 volts, but for speaking sometimes as low as 2 volts, and the design of a transformer to meet these widely differing conditions is a matter of some difficulty.

In order to give an idea of the types of transformers which have been found to be suitable (*a*) for ringing, (*b*) for speaking, and (*c*) both for ringing and speaking, three transformers have been selected which fulfil those conditions, and the following details of their construction may be of interest.

Descriptions of Three Specially Selected Transformers.—(*a*) The transformer known to Post Office engineers as "Transformer, 7 terminal" is a type largely used in the Post Office. The primary coil consists of two wires of 10 mils. diameter wound side by side, each having a resistance of 75$^{\omega}$ and 1700 turns. The secondary winding consists of two wires of 8 mils. diameter wound side by side over the primary coil, each wire having a resistance of 150$^{\omega}$ and 2300 turns. The inside end of one section of the secondary coil is joined to the outside end of the other, and both are brought

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out to one terminal, so that a current sent through the coil from that point acts differentially. The bobbin on which the wires are wound is 4 inches in length and is of cylindrical form with a central hole, $\frac{3}{4}$ inches in diameter, and this is filled with a bundle of soft iron wires, which are turned over the coil at the ends. The weight of this transformer is 2 lb. 12 oz.

The other two coils are of the annular, or, more strictly, of the toroidal form, and both are enclosed in iron covers to prevent overhearing.

(*b*) Repeating coil type 25C has two primary windings, each of 1000 turns of $12\frac{1}{2}$ mils. and 23^{ω}, and two secondary windings consisting each of 1000 turns of 14 mils. and 23^{ω}. Its weight is 3 lb. 4 oz.

(*c*) Repeating coil type 37A has two primary copper windings, each of 1200 turns of 16 mils. diameter and 35^{ω} resistance, whilst the secondary winding has 1200 turns of 18 mils. wire and 30^{ω} resistance, Its weight is 24 lb. 8 oz., the extra weight being necessary for combined speaking and ringing efficiency.

These last two coils are manufactured by the Western Electric Co.

Transformers are often called "repeating coils"; this is an American term.

METHOD OF WORKING ON A SUPERIMPOSED SYSTEM.—Before dealing more exactly with the performances of the transformers, it will be advantageous to indicate the principle of working of the superimposed system. Referring to the diagram it will be seen that we have two metallic loops, *E F H G* and *I K M L*, between *X* and *Y*. At each end of these two circuits transformers are inserted as shown, the primary and secondary windings being, of course, wound upon the same iron core in each case. As a consequence speech conducted, say, on telephone T_1 in transformer circuit No. 1, would cause alternating currents to circulate in the primary coil *N*, and these would be repeated, as already explained, in the secondary coil (*A E G*), and would traverse the circuit *A E F B H G*, which includes the secondary winding *F B G*. The alternating currents would be repeated inductively into the primary winding N_1 and would actuate the telephone T_2. These electrical actions would be confined to transformer circuit No. 1, and would not interfere with, or be interfered with by, currents in any neighbouring circuits, if the wires constituting the loop (the *a* and *b* wires) of circuit No. 1 were revolved round each other so as to be equidistant from any external source of disturbance. Exactly similar remarks apply to transformer circuit No. 2.

A third circuit, called a superimposed or plus circuit, can also be obtained on the two loops referred to by placing two telephones, T_5 and T_6, in the positions indicated in the diagram. In this

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case, starting at the left and following a current originating in the telephone T_5, in one direction, the current would split at *A* and follow the path shown by the dotted arrows, re-combining at *B*, again splitting at *D*, following the dotted arrows, and returning to the telephone T_5 *via C*. As the currents act differentially on the secondary coils the primary coils are not in this case affected.

We may here regard the upper circuit in the diagram as the "*a*" line and the lower circuit as the "*b*" line of the plus circuit, and these two lines must be revolved with each other, just as the two wires making up an ordinary circuit are revolved, and for the same reason. Moreover, the resistance, capacity and inductance of the two loops must be alike, otherwise disturbance will result.

In determining the suitability of any transformer for such a service its behaviour as regards speaking and ringing must be ascertained.

METHOD OF TESTING TRANSFORMERS FOR EFFICIENCY OF SPEECH TRANSMISSION.—In order to find the efficiency of the transformers for speaking purposes the following device was adopted. Two circuits in "standard cables" were used, *i.e.* two circuits in air-space cables, consisting of a large number of pairs of 20 lb. copper conductors one mile in length. By suitable switching arrangements each of these circuits could be varied in length rapidly by steps of one mile, up to any desired length within the range of commercial speech. It was first verified that, with the same speakers and telephones, speech of equal intensity was obtained over equal lengths of the two circuits. Two transformers were then inserted in one of the circuits, in exactly the same way as shown in transformer circuit No. 1 in the diagram, and it was found that although the circuits were of the same length, speech on them was not of equal volume.

TRANSMISSION LOSSES IN TRANSFORMERS.

Length of circuit which contained the transformers.	The following transformers attenuate speech to the same extent as the miles of standard cable shown in the table below.			Remarks.
	Repeating coil, type 25 C.	Repeating coil, type 37 A.	Transformer 7 terminal.	
	miles.	miles.	miles.	
10 miles	1½—2*	3½	10†	* When the 10 miles was cut out and nothing but the transformers left in the circuit the loss was greater than this. † Mean results of tests of many samples.
20 ,,	3	4	10	
30 ,,	3½	4½	10	
40 ,,	4	5	10	

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The length of the circuit without transformers was, however, altered until equality of speech volume was obtained, and the difference in length of the two circuits then represented the attenuating effect of the transformers expressed in miles of standard cable. The above table shows these losses.

DEDUCTIONS FROM TRANSMISSION TESTS.—In order to see the exact bearing of the above losses it should be noted that forty-six miles of standard cable represents the commercial limit of speech, and therefore the effect of inserting the transformers, in either transformer circuit No. 1 or No. 2, as shown in the diagram, would be to reduce the maximum length of line which could be spoken over, as follows:

With 7-terminal transformers . . . 22 per cent.
,, type 37A repeating coil . . . 11 ,,
, ,, 25C ,, ,, . . . 9 ,,

This percentage of loss practically holds good on all types of conductors either in cables or in aërial lines.

If one transformer in a circuit reduces the length which can be spoken over, say, 5 per cent., it does not follow that the transformer has an efficiency of 95 per cent., seeing that the current does not fall off directly with the distance, but follows a logarithmic law. It is, however, convenient to calculate loss in miles of standard cable for practical purposes, and this method has been adopted in the following comparison. For that purpose the best of the coils for ringing is regarded as being of 100 per cent. efficiency, and similarly the best coil for speaking is also tabulated as 100.

The ringing efficiency of the coils was tested by finding the maximum length of cable circuit over which a given magneto-generator would actuate a particular indicator when the transformers were also in circuit.

RELATIVE RINGING AND SPEAKING EFFICIENCY WITH DETAILS OF TRANSFORMERS.

Type of transformer.	Relative efficiency.		Total resistance of coils.		Weight of transformer.	Total turns in primary / Total turns in secondary.
	Ringing.	Speaking (maximum losses).	Primary windings.	Secondary windings.		
			ohms.	ohms.	lb. oz.	
7-terminal	100	86	150	300	2 12	3400/4600
Type 37 A	83	98	70	60	24 8	2400/2400
Type 25 C	50	100	46	46	3 4	2000/2000

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INCIDENTAL ADVANTAGES OF A TRANSFORMER CIRCUIT.—Before finally disposing of the transformer circuit it should be noted that although its use involves a reduction of ringing and speaking efficiency, some advantage results from the fact that all electrical action through it when it is connected at each end to other circuits is inductive, and that consequently the trunk-line included in it is always isolated, so far as metallic contact is concerned, from any circuit to which it may be inductively connected. If it were extended, for example, to a local circuit of which the *a* and *b* lines were of unequal insulation, the resulting disturbance would be less than if the local line were connected to an ordinary metallic loop.

DISCUSSION ON THE PROPERTIES AND EFFICIENCY OF A PLUS CIRCUIT.—Coming now to the superimposed or plus circuit, each of the limbs of this circuit, corresponding to the *a* and *b* lines of an ordinary loop, consists of two wires in parallel, as already explained. We have consequently a circuit of half the resistance, but usually of double the capacity of one of the component pairs on which it is superimposed, and its efficiency for speech transmission, even when the transformers are cut out of circuit, is slightly less than that of one of the component pairs. This is found to be so even in cases where calculation of the attenuation co-efficient indicates that there should be no diminution in efficiency. In such cases, however, it is also necessary to take into account the impedance of the line, which is approximately proportional to $\sqrt{\frac{L}{K}}$, and when K (the capacity) is doubled the increase in impedance as compared with an ordinary line is appreciable. The effect of this increased impedance is reflection loss at the junction of the apparatus and line. If any improvement results from joining wires in parallel it is so slight as to be masked by this loss. If, however, quad pair cable or multiple twin cable* be used for the superimposed system the capacity of the plus circuit is not in this case doubled, as compared with one of the component loops, and some improvement in transmission is therefore obtained in such a circuit. As an indication of the magnitude of this improvement it may be mentioned that the efficiency of speech in cables is approximately inversely proportional to the square root of their capacity. Plus circuits show some improvement in efficiency as compared with standard cable when the length of circuit tested for efficiency of transmission is increased.

The introduction of transformers into a plus or superimposed circuit, as shown in the diagram, attenuates speech to the same extent as from three to four miles of standard cable, the difference

* For an explanation of these terms see "Types of Underground Cable" in the July, 1908, issue of this JOURNAL.

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between the various types of transformers being comprised within those limits.

The plus circuit is subject to one important disadvantage. Owing to the fact that it really consists of four wires instead of the usual two in ordinary telephone circuits it is more sensitive to disturbance than either an ordinary or transformer circuit, and it would appear that in cases where the attenuation in transformer and plus circuits is equal, the former should be more suitable for extension purposes than the latter.

ECONOMIC ASPECTS OF SUPERIMPOSING.—It is of great importance that the attenuation in transformers should be as small as possible, and to illustrate this and show the financial aspect of superimposing I will give one or two concrete examples.

Suppose that two 800 lb. circuits between London and Glasgow were utilised for superimposing, 7-terminal transformers being used for the purpose. The effect of this would be that the transformer circuits so obtained would attenuate speech to the same extent as 23 miles of standard cable instead of 13 miles without transformers as at present, and they would be reduced to the level of 400 lb. circuits for purposes of speech transmission. The plus circuit would be equal to a 500 lb. circuit. Now two 400 lb. circuits and one 500 lb. circuit could be erected at a less cost than two 800 lb. circuits. It is true that the plus circuit does not require to be maintained on the poles, but, on the other hand, it has no recoverable value, and if one of the transformer circuits were to fail the plus circuit would also be thrown out of use. If the best possible transformer were used 4 miles of standard cable would be added to the same circuits, and the three channels obtained would be equal to 500 lb. circuits. Three such circuits could be erected at the same cost as two 800 lb. circuits, and the three circuits would be much more elastic for possible future circuit rearrangements than the three circuits obtained by superimposing. On the whole, therefore, it appears that if we had the option of deciding between the erection of two 800 lb. circuits having an efficiency equal to those just considered, and obtaining three channels of communication by superimposing on them as against the erection of three independent loops of equivalent transmission efficiency, the choice would in the present state of science probably be in favour of three independent circuits. If, however, future possible developments such as loading be considered the advantages in favour of the three smaller gauge circuits would be emphasised.

Next take the case of a very short line only two miles in length in a 10 lb. air-space cable and assume that the reduction in efficiency due to superimposing would be permissible. The weight of copper saved by not utilising a third pair of wires would only be 40 lb.,

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and if there happened to be a spare pair available its use would be preferable to superimposing. If, however, the provision of the third circuit involved the provision of a new pipe the matter would be entirely altered, so that every case should be considered on its merits.

ADVANTAGES OF SUPERIMPOSING.—There are numerous cases where superimposing would be advantageous, as, for example, where existing circuits have a margin of efficiency and could be used for inter-area traffic and in any case where existing plant could be advantageously utilised, especially at times of pressure.

In erecting new circuits with a view to superimposing it is, of course, necessary to so arrange that the circuits shall have a margin of efficiency sufficient to permit of it.

Finally, I think that the considerations reviewed in this article point to the conclusion that superimposing on trunk telephone circuits represents a commercial asset of great value, but that it is subject to many limitations and should be used with discretion.

LONDON TELEPHONES—DISTRIBUTION METHODS.

By H. P. STEED.

THE methods of distribution in the London telephone area will no doubt have to be revised in the near future. Circumstances have brought about three methods of serving subscribers, each of which is confined to a more or less definite portion of the area in question.

(1) In Central London underground distribution has been found to be imperative, and the Post Office has practically no open wires in the City.

(2) In the western portion of the area, where the Department's influence has prevailed over that of the National Telephone Company, underground wires have been provided in the principal thoroughfares, and open distribution has been adopted in unimportant streets.

(3) In the eastern portion, where the National Telephone Company's influence has predominated, open distribution has been strictly adhered to, supplemented necessarily by underground main cables, largely provided by the Department, and rented to the Company.

So far as No. 1 is concerned, only minor alterations may be anticipated. As is well known, the present plant consists of main cables containing between two and eight hundred pairs of wires, which are extended to the City offices by means of 7-pair cables. Conductors of lighter gauge will probably be used, which will enable

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the 20 lb. 7-pair cables to be replaced by others containing more wires, but having the same external diameter. This would avoid the possibility of having to duplicate the distribution pipes, and there would, of course, be an appreciable saving in copper and lead.

With regard to the open distribution mentioned in connection with Nos. 2 and 3, there are distinct differences, as indicated below:

No. 2.	No. 3.
The Post Office poles almost invariably stand in the public footways.	The National Telephone poles generally stand on private property.
Small cables, which rarely contain more than fourteen wires, are led up the poles.	Comparatively large cables are attached to the poles, containing on the average 100 wires.
The wires from the poles enter at the front of subscribers' premises.	The wires are led in at the back of subscribers' premises.

As the Post Office has in many cases provided the main cables, which have been extended to the National poles, apparently the Company's methods have come to stay. It is problematical whether the Post Office methods are really more costly than the National. The prime cost of the latter may be less, but must be accompanied by somewhat heavy wayleave rentals and costly rearrangements due to the withdrawal of easements. The presence of poles on public footways gives rise to objections both on the part of frontagers and road authorities, whereas the wires of the Company, although, perhaps, in the majority of cases crossing private property, do not appear to be greatly objected to. Doubtless, if open wires must be erected, most people would prefer both poles and wires to be at the back of the houses rather than in front. If, however, the National system is to become standard practice, it will be necessary for Post Office engineers to be allowed to adopt what may be called engineering "tricks." For example, recently it was necessary for a small cable to be led from a pole in a back garden to a main cable in the street. There was a mews at the side of the house, but it was paved with cement, and therefore costly to disturb. It was not disturbed. The branch cable was extended through the basement, and a pipe was poked through the front of the house, below the ground-level, into the jointing chamber! There was, of course, an immediate saving, although the house *might* fall down. It is apparent that the officer responsible was a man of resource, and had nothing to fear from superior powers; and here is the moral: Give the Post Office engineer in charge of a section the power to act on his own initiative, allow him a 5 per cent. margin for errors of judgment or bad luck, and the difficulties incidental to open distribution would practically disappear.

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THE APPLICATION OF THE ELECTRO-MAGNETIC CLUTCH TO TELEPHONE TRUNK TIME CHECKS.

By M. F. G. BODDINGTON.

READERS of the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL have had explained to them on pages 201 and 202, Vol. 1, the circumstances in which the piece of apparatus commonly known as a "time check" became a recognised part of a British Post Office trunk telephone equipment, and they are doubtless conversant with the details of its construction and the method of working, since a full description was published in 'The Electrician' of June 15th, 1906.

It is probable, however, that all the later developments in time checks are not so widely known, and the writer therefore hopes that the following particulars will be of interest to engineers and others.

By the use of the electro-magnetic clutch it has been found possible to produce a time check which is extremely simple in construction, reliable and efficient in practice, and economical in respect of cost and maintenance.

A small number of these checks have been in constant use at the London Trunk Exchange since December, 1907, with entirely satisfactory results. They differ slightly, however, from the later pattern shown in the accompanying illustrations, but only as regards the method of mounting. In the one case five checks are placed upon a common spindle and in the other each check is a separate and distinct unit. That the experimental trial has been successful is clearly demonstrated by the fact that the checks have been working during the period with an entire absence of faults; and as they have not necessitated attention since being installed the claim for economy in respect of maintenance appears to be amply justified. The official report regarding these checks is of such an encouraging nature that it is expected the employment of them will be extended.

The apparatus consists of few parts—indeed, it is merely a coil insulated from, and enclosed within, a divided soft iron shell.

The principal dimensions are shown in the illustrations, which represent the exact size of the apparatus, and the method of mounting is indicated in 1.

Upon the iron base *A* a steel shaft *C* is revolved in the direction shown, being provided with suitable bearings and carrying ten wheels, each cut with sixty teeth and mounted two inches apart.

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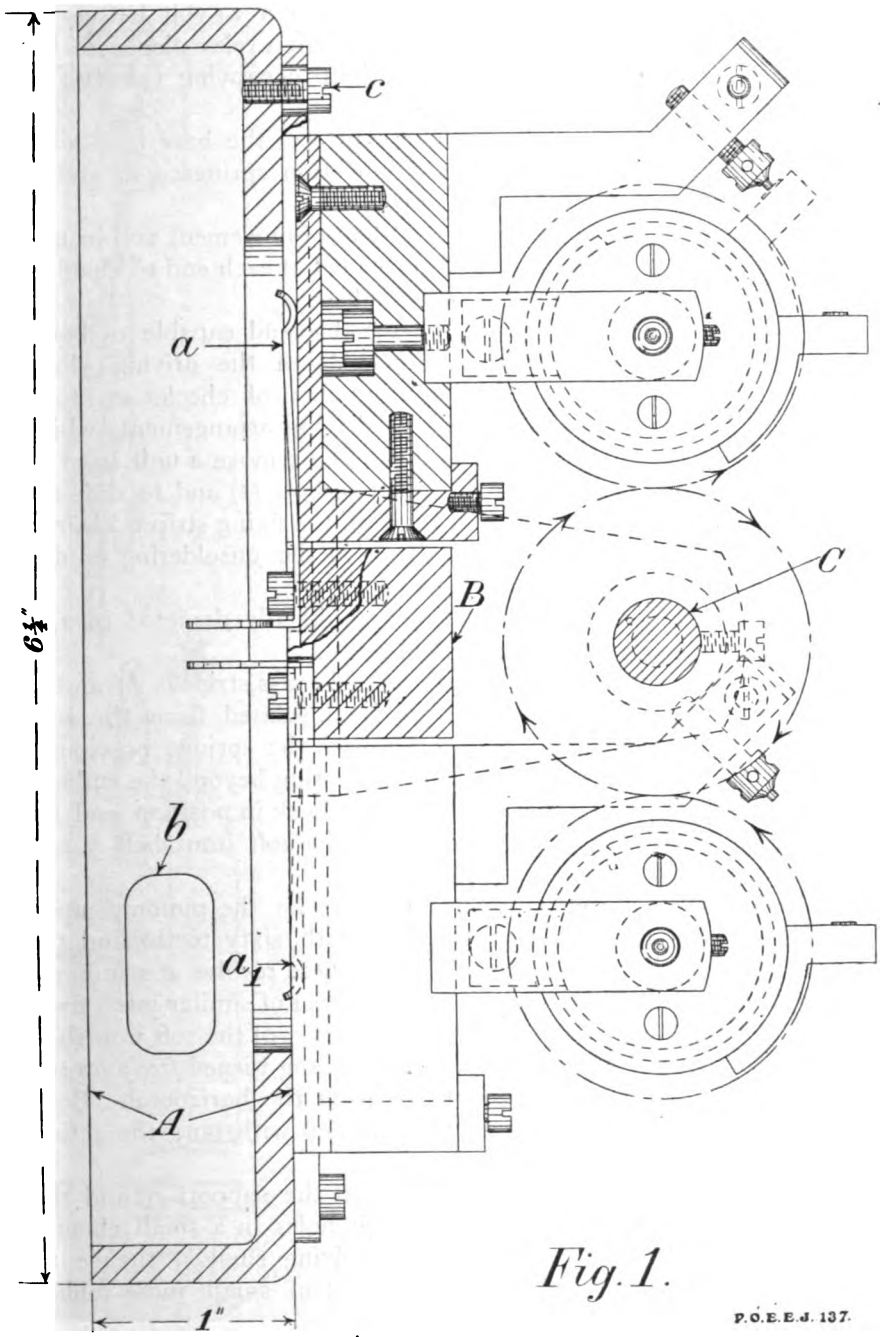

Fig. 1.

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The motion of the shaft is supplied by an electro-magnet, with a ratchet and pawl gear which is driven from a 24-volt battery in response to seconds impulses received through a relay placed in the clock circuit, one revolution of the shaft occupying twenty-four minutes.

The ebonite bar *B* fixed along the centre of the base is suitably slotted to carry the brass tags and connection springs *a* a_1 and to receive the brass fixing-piece *c* (**2** and **3**).

The base is cut away to secure freedom of movement and insulation of the springs, and a hole, *b*, is provided at each end to enable a 42-wire cable to be run in from either side.

The time check units are interchangeable and capable of being employed in any position on either side of the driving shaft. The base is designed to carry any number of checks up to a maximum of twenty, together with the driving arrangement, which is not shown, however, in the drawings. To remove a unit from its position it is necessary only to take out screw *c* (**1**) and to slide the check up or down, as the case may be, until the fixing strip is clear of the ebonite bar *B*. This does not involve the unsoldering or disturbance of any electrical connections.

Details of the time check itself are graphically depicted in **2**, **3** and **4**, and may be summarised as follows—

Through an ebonite block *a* are carried brass strips *b*, b_1 and *c*, the two former being so placed as to be insulated from the iron base, but to make electrical connection with the springs previously mentioned. The centre brass strip projecting beyond the ends of the ebonite block is utilised for fixing the check in position and for connecting one side of the coil, as well as the soft iron shell *h* and arm *j*, to earth.

The brass L-pieces *e* e_1 form the support for the pinion *f*, upon which are fixed the brass wheel *g* (cut with sixty teeth) and the larger portion of the soft iron shell *h*. These revolve at a uniform rate as a result of *g* being in train with a wheel of similar pitch fixed on the moving shaft *C* (**1**). The smaller portion of the soft iron shell *j*, carrying a projecting arm, is capable of being turned *freely* on the pinion within an angle of about 50° from the horizontal. Both portions of the iron shell are well coppered to withstand the action of rust.

The coil *d*, wound to 1000$^{\omega}$, is fixed to the support e_1, and the ends of the conductor are taken through holes in a small ebonite block to keep the wires clear of the revolving shell *h*, thence to connection screws *m n* (*A*) through pieces of small india-rubber tube.

The brass pillar *l* is provided with an adjustable screw for the purpose of timing, and is in electrical connection through one of its

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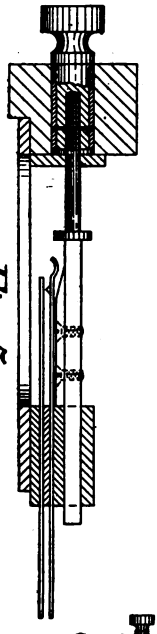

Fig. 5.

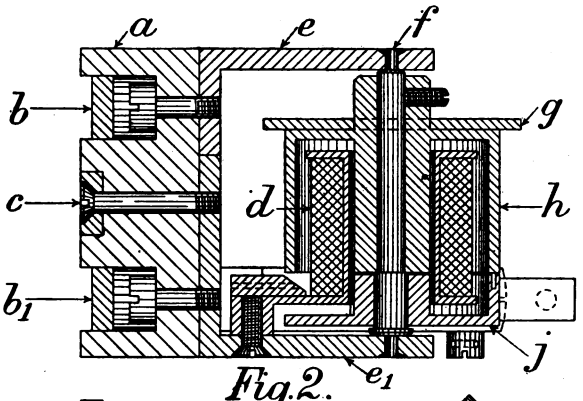

Fig. 2.

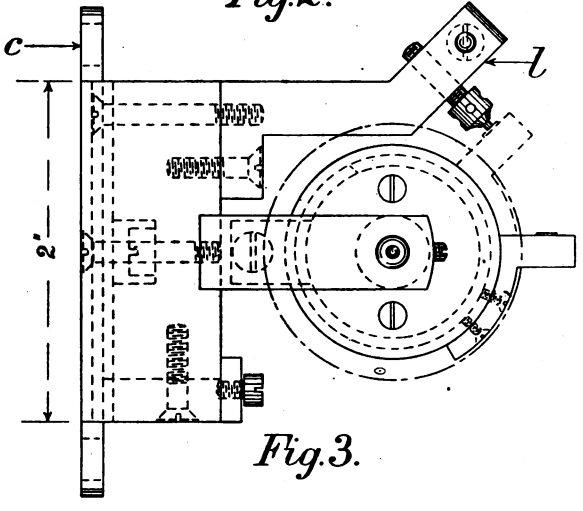

Fig. 3.

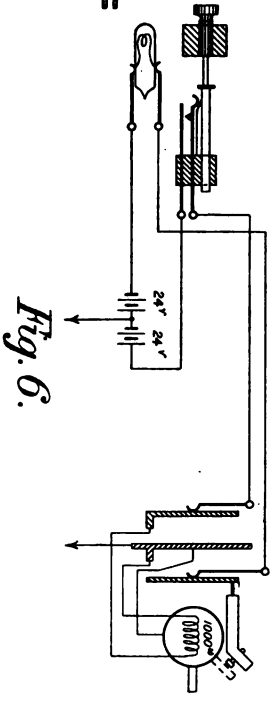

Fig. 6.

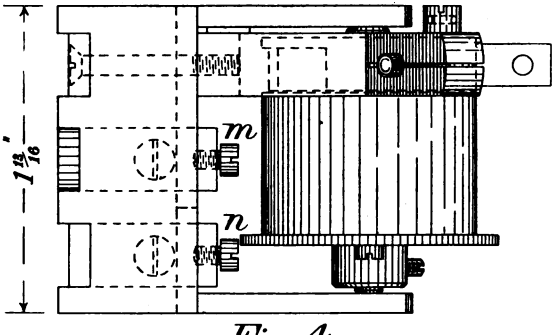

Fig. 4.

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fixing screws with the brass strip b_1 and its corresponding spring and tag.

5 shows an end section of a strip of keys, which is placed immediately above the line lamps associated with the trunk switch-springs.

The portion of the key rod which is hidden when in the position shown is coloured pink. When the key is pulled out the coloured rod is visible to the operator, and provides an indication that the time check has been put into operation.

6 shows a theoretical diagram of connections, and the method of working may be explained as follows:

Assuming the key to be pulled out, the circuit is completed, and a current from the 24^v battery energises the coil, causing the two portions of the soft iron shell to clutch and to form an almost complete magnetic circuit. That portion marked *h* is, as previously stated, already being continuously and slowly revolved; the other part of the shell *j* carrying the projection is now raised from its position of rest, and carried round until contact is made with the pillar *l*. The line lamp is thus joined up to the battery, and the resulting glow indicates to the operator that the specified period of time has expired.

Although the projecting arm attached to *j* is now stopped in its progress by contact with the pillar *l*, the wheel *g* and the portion of iron shell *h* continue to revolve, a slipping electro-magnetic clutch being now maintained. A small air-gap between the two clutching surfaces permits of this slipping action, the rim of *j* being studded with a number of brass pins which project about 3 mils, and prevent actual contact of the parts.

The action of pushing in the key breaks the circuit, releases the clutch, and allows the arm to drop to its normal horizontal position by reason of its own weight.

It is considered to be an advantage that the operators can see whether or not the time checks are in operation, according to the position of the key, and it is stated to be a useful feature that the supervisors are enabled to observe whether the timing apparatus is being utilised.

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CARDIFF NEW UNDERGROUND SYSTEM.

By C. J. YOUNGS.

THE new Exchange for Cardiff subscribers will be served by new underground routes which have been laid throughout the city and well into the suburbs.

The new plant is of the cement block type favoured by the National Telephone Company. It has not hitherto been used by the Post Office. The methods adopted for laying these are as follows:

The bearers for carrying cement blocks have to be laid at right angles to the line of trench and level as regards cross section thereof. The earth between the bearers must be well rammed and levelled so that the blocks take a solid bearing throughout their entire length. Bearers are not provided in the case of 3-*way blocks*, as they are made after the fashion of the spigot and socket arrangement.

The cement blocks must be carefully laid in position, each resting for an equal distance on the bearers with the ends abutting closely, or with a space of $\frac{3}{8}$-inch left between the ends as may be directed. Care should be taken that the inside of each block is kept free from all obstruction, and that all the holes in each block exactly correspond with those of the block on which it abuts, or when the testing time arrives trouble will also arrive. Wrought iron bars of suitable sizes are placed in the longitudinal grooves of the blocks made for the purpose, and must be so arranged that no bars meet between blocks and not more than two bars meet on the same block.

A strip of canvas of suitable width and length, coated with melted asphalt of an approved quality, is passed completely round the joint, overlapping the ends of the two blocks and passing between them and the bearer and over the iron jointing bars. The space between the blocks and bearer is then filled up with cement grouting, and the recessed portion and grooves of the blocks filled with neat cement carefully trowelled in, the iron jointing bars which fit into the grooves in the blocks being properly bedded in cement throughout their whole length. The asphalted canvas is omitted in the case of 3-way blocks, the space left in the spigot and socket joint arrangement being filled in, and the joint properly trowelled over with neat cement. The work has to be so carried out that the blocks shall not be disturbed while the cement joints are setting.

The free ends of the blocks are securely stopped with wooden plugs when the work is left at night or at any other time.

Each section of blocks is tested on completion by having a mandril composed of a piece of wrought iron pipe covered with lead, 4 feet long, $2\frac{7}{8}$ inches diameter over all, drawn through to ensure a perfect way for the reception of the cables. The mandril must pass easily through without being cut or distorted in any way, and a

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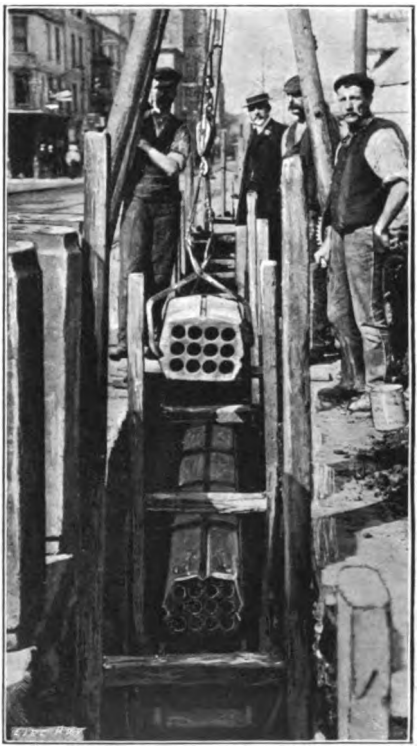
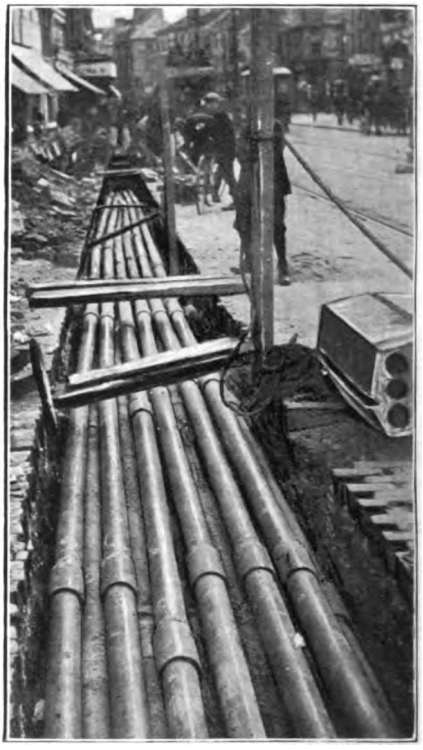
similar test is made on completion of the whole of the work. 1 illustrates the laying of 12-way blocks in Queen Street, Cardiff.

The experiences met with in carrying out work of this kind are various and interesting.

It is absolutely necessary to have the whole length of trenching open for one section before block laying in that section can commence, or it is possible that the work of laying will be quite in vain. Obstructions and sundry difficulties have all to be overcome prior to



1.—Laying 12-way Blocks.



2.—Pipes for Shallow Depth.

a length being given over to the block-layers. This also means that the next section has to be well in hand by the time the block-layers are fairly starting on their work in the adjoining length or delay will ensue in regard to their operations. Further, the trench has to be practically straight as no appreciable bends or turns can be given with such blocks.

The method of testing out is also of interest. The 4-feet mandril, $2\frac{7}{8}$ inches in diameter, which is fed into the blocks with sweeps' rods and a rope, has to pursue its course easily and freely through the entire length, or the filling in of the trench cannot proceed. The

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use of the mandril in proving the alignment of individual blocks, as they are added to those already laid, gives an experienced man an idea as to whether the whole course, so far, is correct and acceptable.

In some instances it is not possible to lay the blocks, such as at points where the road bends considerably and there is no chance of obtaining a length straight enough, or in cases where bridges have to be negotiated and there is not sufficient depth. Then recourse is had to pipes.

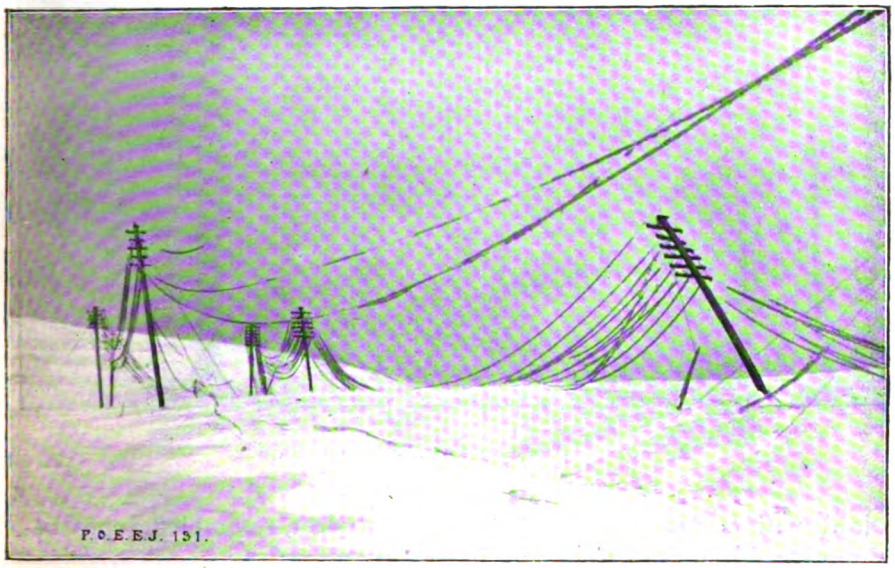
2 shows the method adopted at a shallow bridge over a canal in Queen Street, Cardiff. In this case the blocks had to be substituted by pipes, and these had to be jointed by the collar method as space for the ordinary socket was not available.

Thanks are due to Mr. E. B. Tutton for the photographs.

BLIZZARD DAMAGE.

By F. W. BEST.

THE accompanying photographs illustrate breakdowns which occurred on main lines on the borders of south-east Lancashire



1.—DUNFORD BRIDGE, MARCH 11TH, 1909.

in the North-Western District as the result of the blizzard on March 11th last.

1 and **2** were taken near Dunford Bridge and convey a good

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idea of the severity of the storm. Here two lines of telephone and telegraph run parallel, and traverse high and exposed moorland some distance away from the high road.

The breakdown extended over a distance of half a mile and involved the collapse of four poles on the telephone line. Classed under the old specification as "stouts" these poles would at the present time only pass muster as "mediums." The wires, weighted

2.—Lines Damaged near Dunford Bridge.

down with continuous coverings of frozen sleet, resembled ropes of from three to four inches in thickness.

The telegraph wires consisted of 300 lb. copper, while the telephones, with the exception of four wires of 150 lb. gauge, were of 200 lb. copper.

Interruption cables were used to bridge the damaged sections and it is noteworthy in this connection that the drums of cables

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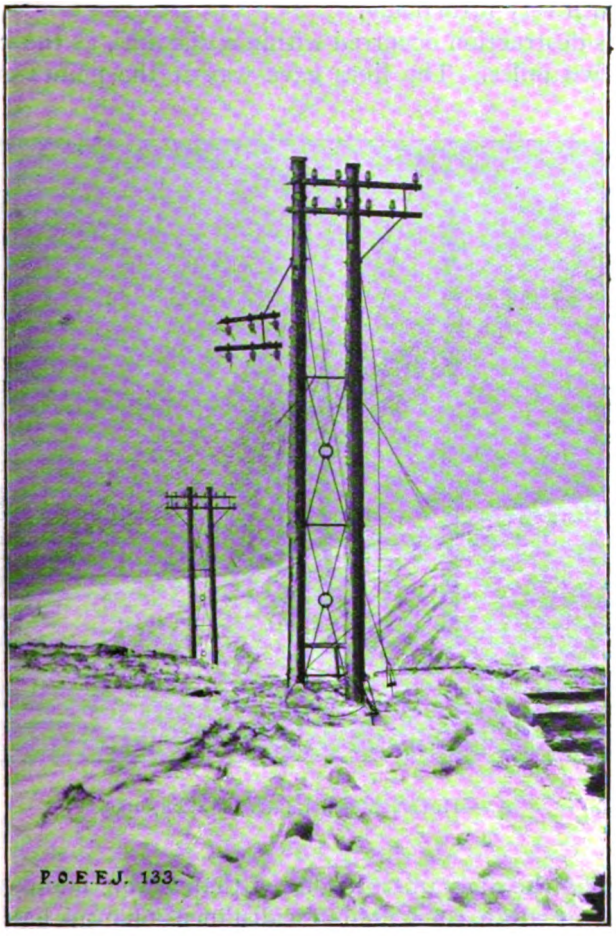
wired for on the afternoon of the breakdown were promptly despatched from London and delivered at Dunford Bridge station, nearly two hundred miles distant, by daybreak on the following morning.

3 and 4 were taken at Holme Moss, on another route, after the ice had entirely disappeared from the wires. Owing to the com-



3.—Holme Moss, Lancs., March, 1909.

parative newness of the timber the poles on this line suffered practically no damage, although the line stands three hundred feet higher above sea level, and is therefore exposed to a much greater wind velocity. The ice accumulations were, however, greater than in the first-named locality, the arms and insulators on each pole being practically embedded in a solid block of ice, and the arms

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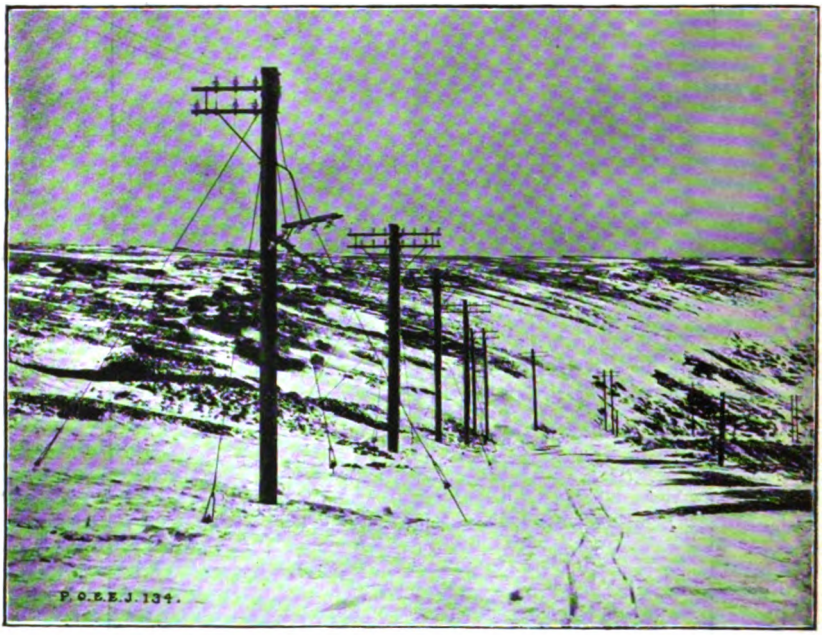
in three cases being broken off, notwithstanding the strengthening afforded by combiners and arm stays. A piece of ice removed from the wires was found to measure seventeen inches in circumference and weighed four and a half pounds per foot.

Past experience at this wild and bleak spot had shown the necessity for underground emergency cable, and the employment of this cable, which was laid a few years ago, enabled the circuits to be restored with very little delay.

All this destruction occurred within a distance, as the crow flies, of thirty-two miles. The lines gave way at the points cut by the



4.—Holme Moss, Lancs., March, 1909.

dotted line in the diagram. No fewer than seven main lines were broken down within a few hours for distances of from half a mile to two miles, involving the interruption of every wire. All gauges up to 300 lb. copper suffered equally. Four wires of 600 lb. copper on the Marsden line suffered least, and were broken down to the extent of five spans only. On one pole, however, the arms carrying these wires were broken off.

Other main lines in the neighbourhood were also crossed by the blizzard, but being at much lower levels suffered little or no damage.

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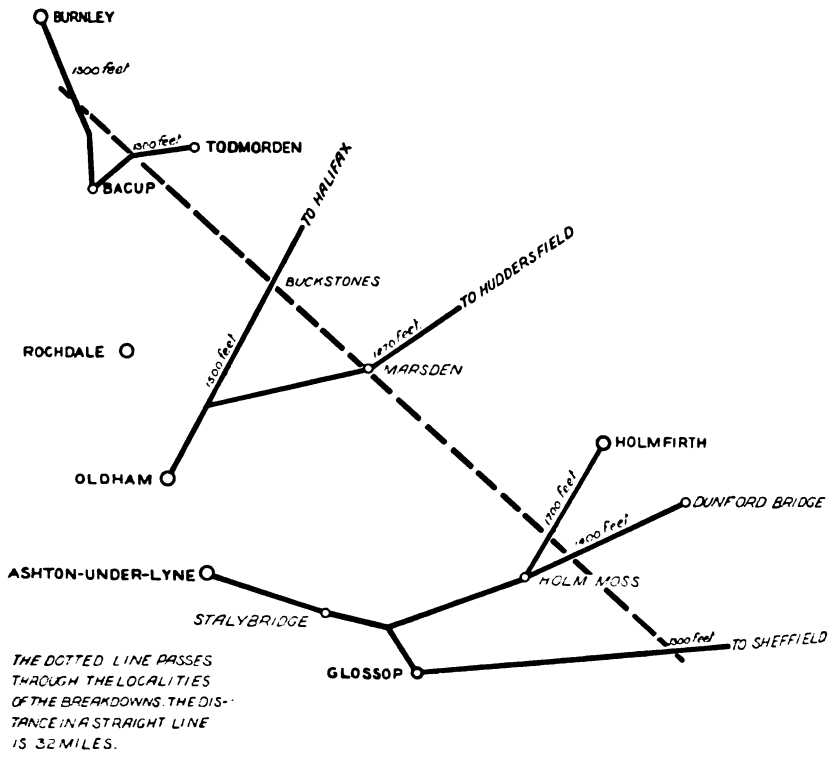

STORM ROUTE, LANCASHIRE, MARCH 11TH, 1909.

SOUNDER SILENCERS AT TELEGRAPH REPEATER STATIONS.

By JAS. J. HARDIE.

THE number of Post Office telegraph circuits, both provincial and continental, which exceed the limits between which direct working is practicable is very large. It is necessary in such cases to establish a "repeater" on each circuit at some point approximately midway between the terminal stations, and thus to provide for reinforcing the signalling currents, which would otherwise be attenuated below the strength required for actuating the apparatus at the receiving end. Such repeaters are built up by suitable combinations of relays, switches, balancing apparatus, etc., on principles which are well known, and they also provide means whereby the signals passing on the circuit can be reproduced locally on tape receivers and sounders in order to enable the attention of the

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repeater station to be gained, when necessary, by the terminal stations, and to facilitate supervision and adjustment.

The exigencies of practice have led to the concentration of large numbers of repeaters at offices in favourable geographical positions, where a small staff of specially trained repeater clerks is generally maintained to attend to them.

The local sounders associated with the repeaters are worked by relays energised by leak currents from the repeating batteries, and, as originally arranged, these sounders were continuously in circuit, and reproduced the whole of the working signals passing on the wire. It can readily be imagined that in a large repeater station where thirty or more sounders might be continuously working, the result was not only irritating to the repeater clerks, but also made it very difficult to distinguish a call for the repeater station in the general Babel of telegraphic signals.

To improve this condition "sounder silencers" have been introduced. Their function is, as the name implies, to silence the repeater sounders in normal conditions and to enable them to be brought into operation only when actually required. Means have therefore to be provided whereby the silencing devices can be controlled electrically by the distant offices, and manually by the repeater clerks themselves. The lot of the latter has thus been sensibly ameliorated, and no doubt they are duly grateful. While all is going smoothly the repeater station is characterised by a placid and dignified silence, but when a failure occurs at any terminal station the corresponding sounder can be brought into circuit, and will thus readily attract the attention of a repeater clerk to the call for his assistance. The general method of bringing in the sounder is by sending a long "marking" current; the signalling key at the calling office is depressed for a period of about twenty seconds, after which the code call for the repeater station is signalled until a reply is received.

Clockwork Silencer.

The silencer most largely used at repeater offices consists of an electro-magnet with an armature lever carrying a pawl which acts upon a revolving cylinder driven by a clockwork motor. The joint action of these is controlled by the distant sending offices in such a way as to bring the relay station sounder into circuit when required. **1** shows the general arrangement of the apparatus, and **2** and **2***a* give the electrical connections for primary and for secondary batteries respectively.

From the diagrams it will be seen that a current flows through the silencer electro-magnets so long as both transmitting relays have

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their tongues on the spacing contacts. In ordinary working this occurs many times in a minute. If, for any reason, the tongue of one of the relays remains on the marking contact for twenty seconds continuously, the silencer circuit is broken for this length of time, and by the means now to be described the sounder at the repeater office is brought into use.

In 1, *C* is a cylinder revolving continuously. Resting on the surface of this cylinder is the pawl "*p*" hinged to the armature lever which carries the contacts of the sounder and silencer circuits. The

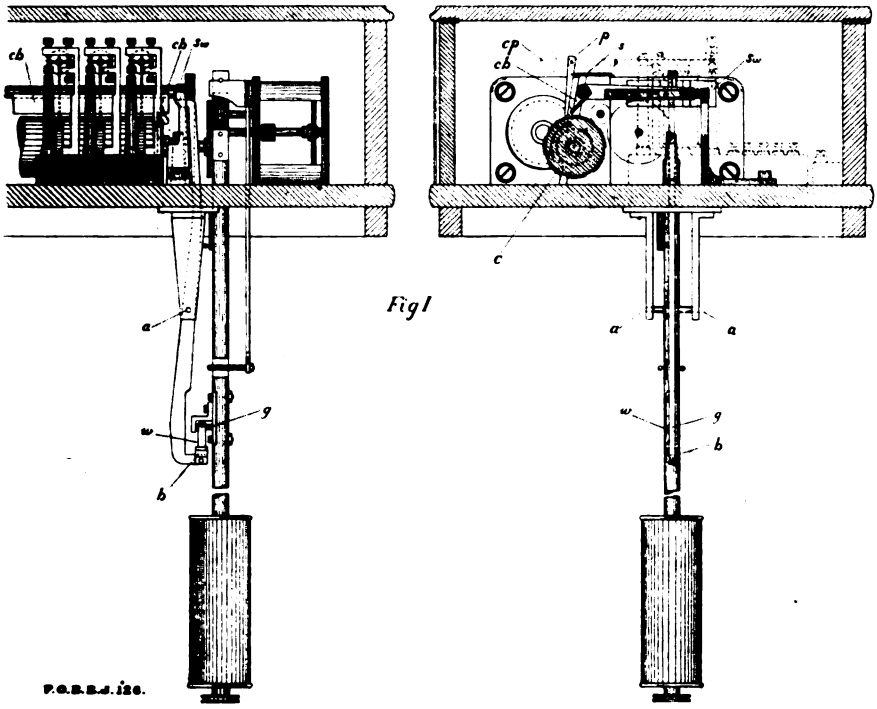

Fig 1

1

pawl is held lightly against the cylinder by the spring "*S*," and slides freely on the revolving surface of the former so long as the electro-magnet is energised. The armature lever is fitted with a bob or counterpoise "*cp*," which, if the pawl and its auxiliary spring were not present, would overbalance the armature immediately the silencer magnet circuit becomes disconnected. Whenever short disconnections in the silencer circuit take place, *i. e.* when one or both of the transmitting relays are marking, the weight of the "bob" tends to raise the armature and so close the sounder circuit, but the pawl prevents the armature from rising at the instant. If

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the disconnection is prolonged, however, the weight of the "bob" causes the end of the pawl to be drawn round with the cylinder, and at the end of twenty seconds the lower end of the pawl has been

2

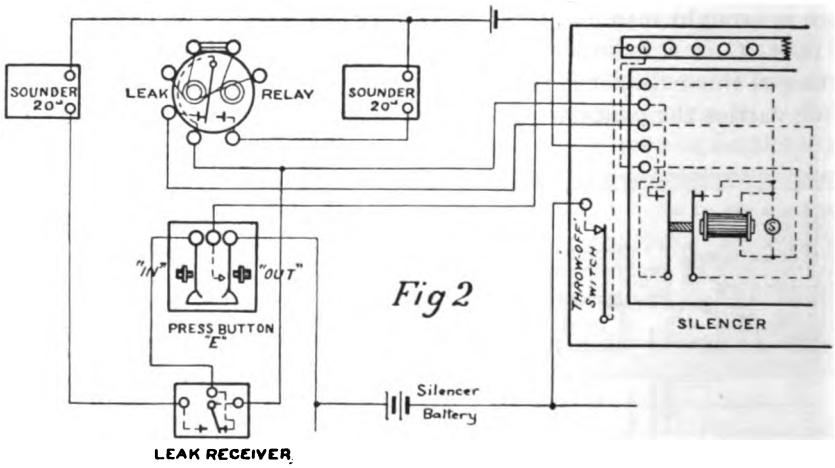

Fig 2

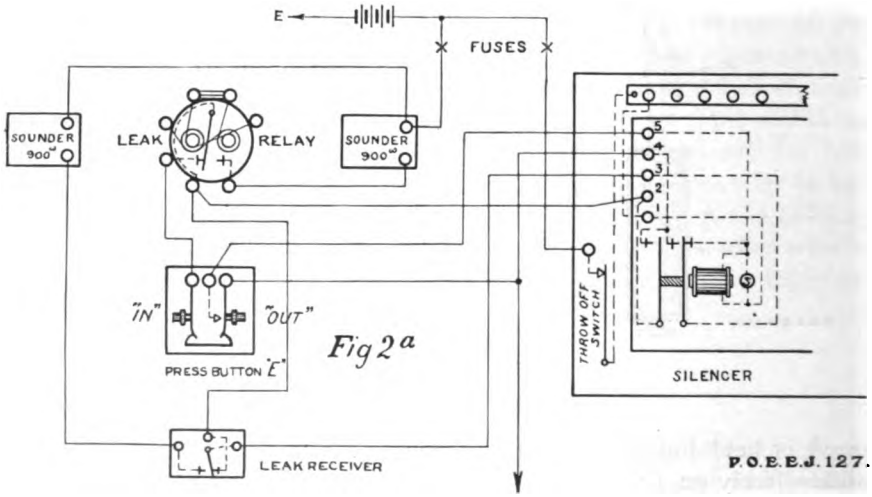

Fig 2a

2a

turned through such an angle as to allow its point to disengage from the cylinder and permit the "bob" to fall and the armature to rise. The rise of the armature causes the silencer circuit to be broken and the sounder to be joined up through the upper contact studs and the flat contact springs of the other end of the armature lever. When the circuit has received attention the silencer magnet is energised by

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the depression of the button marked "*OUT*" in **2**. The bringing in of the sounder is manually effected by the depression of the button marked "*in*" in the same diagram.

To the pendulum of the clockwork driving the cylinder is fitted a pawl or "wiper" "*w*," loosely pivoted at "*g*." During the normal oscillation of the pendulum the "wiper" slides over the block *b* fixed on an L-shaped lever pivoted at "*a*," and falls clear of the block at the end of each oscillation. If for any reason, such as the running down of the clockwork, the amplitude of oscillation is reduced until a point is reached when the "wiper" fails to slide clear of the block, the next swing causes the "wiper" to "dig" into the block, and causes the L-shaped lever to move through a certain angle. This motion operates the throw-off switch "*Sw*" and a continuous bar "*cb*," the former disconnecting the silencer battery circuit and the latter throwing all the silencer pawls clear of the cylinder "*c*."

In this type of silencer the electro-magnets and clockwork are accommodated in a cabinet apart from the repeaters, thus necessitating a large amount of wiring that would be unnecessary if the "silencing" apparatus could be placed at the repeater with which it is associated. Several attempts to overcome this difficulty have been made, and two or three interesting methods of doing it are described hereafter.

Circuit Silencer (3).

In the "pneumatic" type of silencer (3), which, to prevent confusion, I shall term the "circuit silencer," the clockwork cylinder and pawl have been dispensed with.

The "bob" or counterpoise "*b*" of the armature is provided as usual, but the end of the armature lever distant from the "bob" is fitted with a wire "*w*," to which is attached an oiled silk diaphragm "*d*," covering a compartment which is airtight except for the outlet valve "*v*" and the small inlet "*i*." When the armature is depressed the oiled silk diaphragm is also depressed, thus reducing the capacity of the air-chamber, from which a quantity of air is expelled through the valve "*v*." If the armature now attempts to rise through the action of the counterpoise, it is prevented because of the slowness in the rise of the diaphragm, which is brought about by the rate of influx of the air being cut down through the smallness of the inlet "*i*," which is adjusted by means of the screw "*s*," so that the sounder is brought in when the magnets have been de-energised for twenty seconds.

The "circuit silencer" can be accommodated at its repeater, and from the point of view of prime cost it is superior to the ordinary

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sounder silencer, but it is open to the objection that its use involves a continuous consumption of current.

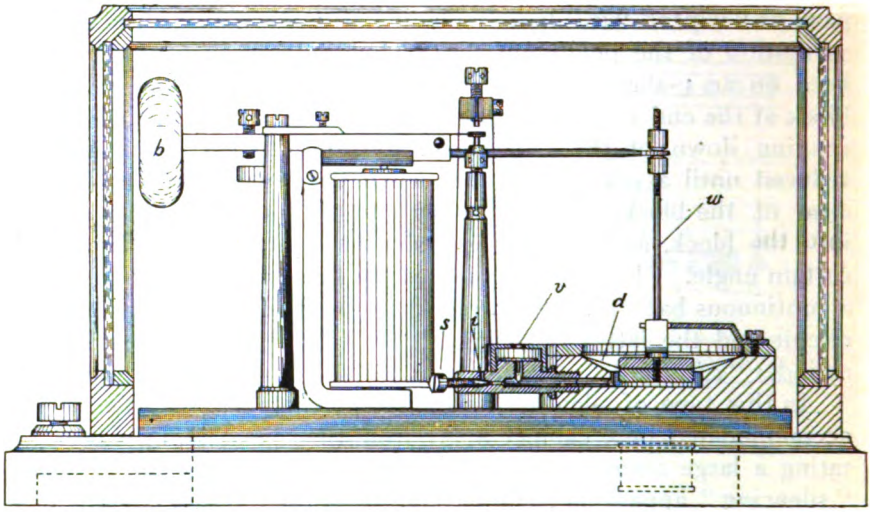
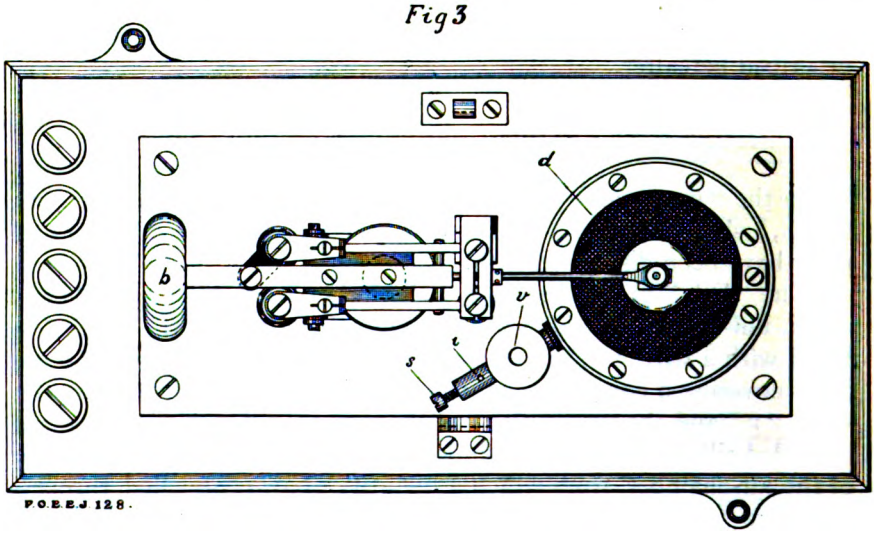


Fig 3



Silencer, with Condenser and Resistance.

A form of silencer was suggested recently by Mr. Donald Murray, and a modification of it by Mr. Godfrey is under trial. This form has the advantage that a permanent current is not required. The principle employed in the operation of the apparatus is well known,

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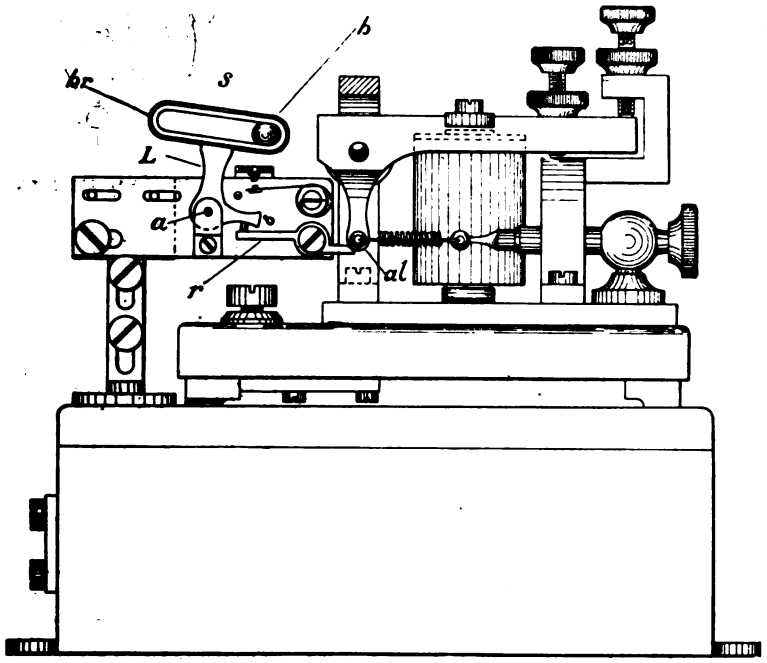
and it is surprising that it has not been utilised for this purpose before. It can best be discussed from the skeleton diagram in 5.

One condenser, one special switch, and one megohm resistance are required for each sounder (or two of each per ordinary duplex repeater). When the relay is "spacing" the 900ω sounder shunts the condenser, and when "marking" the 2 mf. condenser is being gradually charged through the resistance of one megohm, this shunt circuit being broken. The adequate charging of the condenser takes a little under twenty seconds. When the relay tongue returns to the



4

spacing stop after an ordinary short marking signal, the condenser plates which have been charged to a comparatively low potential, discharge through the sounder without effect as the energy stored up in the condenser is insignificant. If, however, the relay tongue had been maintained at the marking side for twenty seconds the potential difference of the condenser plates would, of course, be greater, and the discharge current through the sounder would be sufficient to attract the armature momentarily. The attraction of the sounder armature automatically throws a switch "*s*," which joins up the sounder battery circuit by the action of the tailpiece of the armature lever "*a l*" (4). The switch consists of a short

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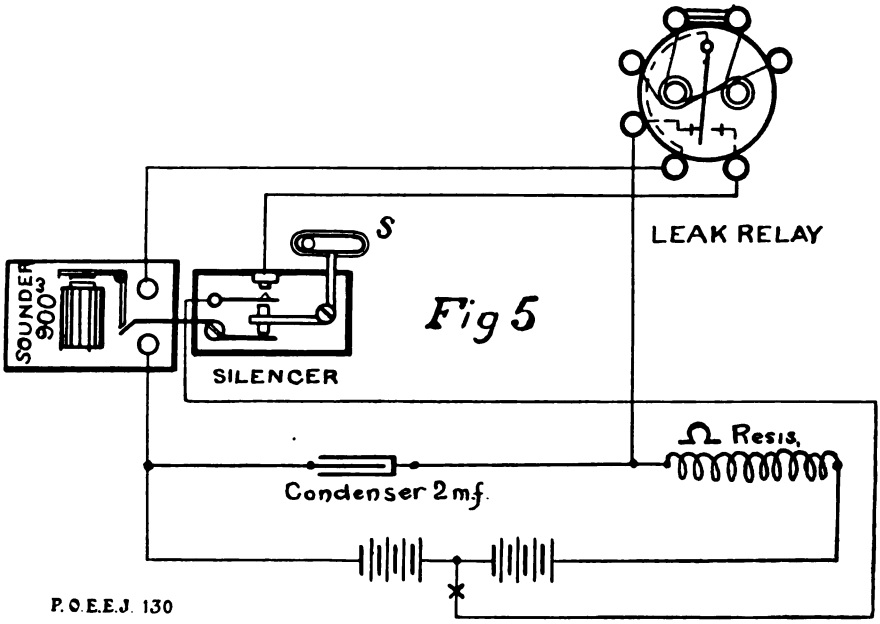
ball race "*br*" attached to a bell crank lever "*L*" pivoted at "*a*." The ball "*b*" is normally to the right (4) and keeps the L-shaped lever "*L*" against the rocker "*r*." The operation of the sounder causes the lever "*L*" to be tilted and the ball to roll to the other end, where it remains until the lever is re-set by hand.

A further modification of this silencer is in hand.

In all the foregoing types of silencers it is necessary for the leak relays to have a spacing bias.



5

Hughes Silencer (6).

In Hughes Repeater Offices whenever Morse signals are heard it may be taken as an indication that the repeater wants attention, as the terminal offices must call the repeater station by the Morse code. It is rather monotonous at a repeater station to have to listen to the irregular series of dots constituting the Hughes signals, and an effort to remedy this has led to the design of a simple contrivance which will respond to Morse signals but not to the Hughes.

It consists of a large wheel *w*, mounted on a common base with the Morse sounder. Near the periphery of this wheel is mounted a block *b*, so placed that the centre of gravity of the combination is above and to the left of centre *c* of the wheel (6) when pin "*p*" on the wheel is in contact with "*el*," an extension lever of the sounder armature.

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When Hughes signals are sent the lever "*el*" tends to push the pin "*p*" downwards and so revolves the wheel about its centre, but the signals are so short and so intermittent and the inertia of the wheel is so great that it is not moved, and the armature lever is consequently never depressed. On the other hand, a dash or Morse signal gives the striker or extension lever "*el*" sufficient sustained

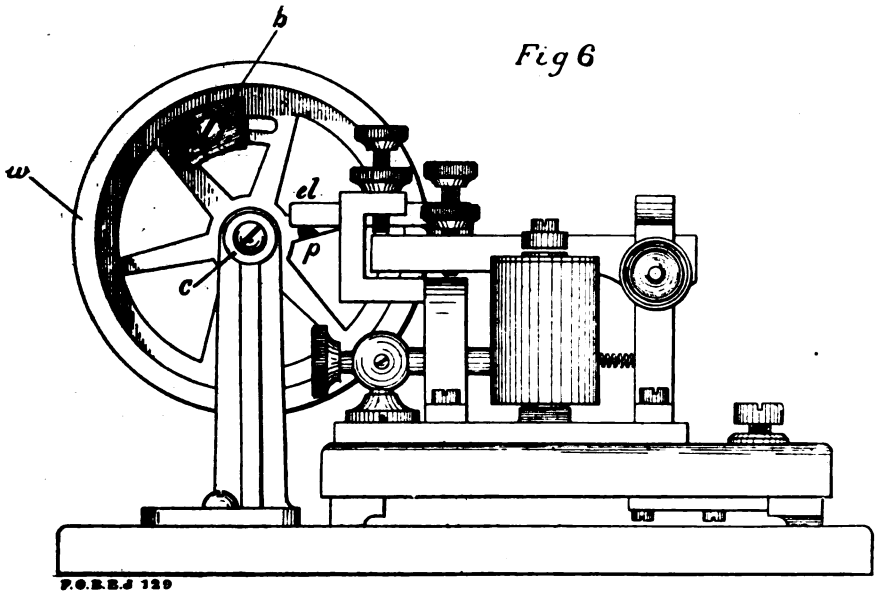

Fig 6

6

energy to drive the wheel over the dead centre and so remove the centre of gravity to the other side of *c*. This frees the sounder armature lever to be operated, and the attention of the relay clerk is now readily gained. When the necessary communications have been made the wheel is restored by hand to its normal position.

An advantage of this silencer over all the others mentioned is that the attention of the repeater station is gained without the usual "wait" of twenty seconds.

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THE MACHINERY OF THE POST OFFICE.

By H. A. MILES.

II. POSTAL CONVEYORS.

I MUST commence by acknowledging my thanks to Mr. E. W. Pettit for almost the whole of the following article, and for the very excellent illustrations. Pressure of other work obliged me to ask for a few notes which his very intimate acquaintance with the subject would have rendered valuable and of material assistance to me in penning my article, and the unexpected result was really a detailed history of the conveyor—past, present, and future—so complete that I found there was very little left for me to add.

The use of conveyors as labour and time-saving devices in the sorting offices of our chief towns is of comparatively recent date, and the whole question is even now in its infancy.

The design of mechanical sorting arrangements presents many difficulties, as one has to deal with a service which from its broad principles down to the minutest details possesses a very high state of organisation, and therefore extreme sensitiveness to change.

In many cases it is an absolute impossibility under existing conditions to alter the routine of the offices, or to make any radical change in the disposition of their fittings. Under these circumstances it will be understood that anything like a complete system for conveying and distributing the correspondence is a practical impossibility, so that conveyors when introduced rarely work under the best conditions, and the resulting efficiency is therefore less than would be the case if it were possible to organise the office on the basis of mechanical distribution.

Estimates as to the saving which would be effected by the introduction of these machines vary very considerably, amounting in one instance to as much as 30 to 40 per cent. per annum of the capital cost of the installation, whilst in others little or no monetary gain can be anticipated, the improvement being in economy of time and reduction of traffic across the sorting office, thus rendering supervision more easy, and facilitating the orderly working so difficult to obtain with men and trucks moving in all directions. The latter improvement is of very great importance, and will be fully appreciated by those readers who have had the opportunity of watching a sorting office during its busiest hours.

The nearest approach to comprehensive schemes are those proposed for the "King Edward's Building" and for the Parcel Office at Mount Pleasant. In almost every other case it has been possible to deal with only one particular duty.

Conveyors may be roughly divided into two classes:

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(*A*) Those giving continuous delivery.

(*B*) Those giving intermittent delivery.

Class A comprises: endless belt, steel plate, spiral and creeper conveyors, bucket and finger-tray elevators, etc.

Class B includes overhead runways, transporters, and others of the crane type. With very few exceptions those in Class B are unsuitable for Post Office use, as owing to their construction and the necessity for fixing them on the ceiling of the offices, they are likely to cause injury to the staff in the event of failure of any part of the travelling mechanism or structure; also, the delivery of correspondence not being continuous, it follows that the ability of the machine to deal with rushes of work during short periods is strictly limited.

On the other hand, those mentioned under Class A give continuous delivery; they are thus well able to meet the sudden and heavy demands which frequently occur throughout the day in large offices, avoiding by a steady flow of packages, congestion at either the loading or delivery end.

The adoption of any of these forms of conveyors, involves little or no danger to the staff, however they may be placed, whether on the ceiling or under the floor of the office.

In large and busy centres where the sorting office is on the ground floor it is a decided advantage to place the whole of the machinery in the basement, thus avoiding interference with the lighting and allowing an uninterrupted view across the office (an important consideration where several conveyors are to be installed), and in the event of breakdown the repairs may be carried out without inconvenience to the staff or delay of the work. The disadvantage of such an arrangement is that the correspondence disappears from view during transit, and it is therefore possible that isolated letters or packets may be hung up on the conveyor and delayed for hours, or even days, unless a systematic inspection of the route is ensured.

For equal capacity the under-floor arrangement is at least 10 per cent. more costly than one carried on the ceiling, and necessitates cutting large holes in the floor.

Of those types given under Class A, the two most easily adapted for Post Office use are: For horizontal distribution, the endless belt conveyor; for vertical distribution, or a combination of the two, the finger-tray elevator. Perhaps the best way to proceed with the subject will be to combine the description of various installations, existing and proposed, with a brief history of the development of mechanical aids to sorting as far as it is known.

During the early part of 1893 a slowly moving belt was fixed upon a facing table in the G.P.O. (East), and arranged to run down

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the centre of, and at a height of about 12 in. above, the table top, for the purpose of carrying the faced letters to one end of the table, and so avoiding the continual defacement which took place when they were passed from sorter to sorter. After an extended trial the conveyor was unfavourably reported upon and removed. A suggestion was then made to place a belt running in a trough on each side of the table, and level with the table top, for each man to lay letters on as they were faced, but so many objections were raised to this proposal that the matter was dropped.

Early in 1903, on the completion of the new Savings Bank Department, it was decided to instal a conveyor for the purpose of carrying correspondence to and from the main building and the District Post Office, situated at a distant corner of the site. This conveyor has an effective length of 75 ft., and consists of two belts, one running in either direction, with the motor and gear placed between them; the belts are driven through bevel wheels, by means of straight and crossed belt gearing to give the necessary reversal of direction for the second belt. The warrants, deposit books, etc., are packed into large baskets of sufficient width to take a double row, the loaded baskets having a gross weight of over 70 lb.; the baskets are placed on the conveyor feeding table when only partially loaded, being then packed and pushed on to the moving belt. On arrival at the Post Office they are swept by the belt on to a table, from which they may be removed by the sorting staff. These operations are reversed when sending correspondence from the Post Office to the Savings Bank. This conveyor is still rendering extremely useful service.

Early in 1905 a couple of working models of conveyors were made. Letters, etc., were to be placed by the sorting staff in a series of shoots, through which the traffic dropped upon different belts running beneath the table. Vertical conveyors collected the traffic from these belts and carried it up to another series of horizontal belts overhead, which conveyed it to the desired points. The difficulty not fully grasped at this early stage was that the letters should be "faced" at the sorting table.

In May, 1906, a conveyor of the endless belt type was installed in the Manchester Head Post Office, running over the sorting tables, and placed at such a height that the men opening the mail bags could throw the correspondence on to the belt, which carried and finally deposited it upon the stamping table. The effective length of the conveyor is 104 ft., and the belt is of 3-ply canvas, 15 in. wide, 220 ft. in length, and runs at an approximate speed of 200 ft. per minute. A 4 brake-horse-power motor, located in the basement, is provided, and drives the conveyor through spur and belt gearing. The conveyor is mainly supported by pairs of cast-iron standards,

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1 in. in diameter, about 5 ft. apart, fixed to the tables by means of screwed sockets. The rollers are of hard wood, with brass bushes and flanges, running on a stationary spindle, which acts as a lateral stay between each pair of supports; the sides or guides are formed of wire mesh in a wood frame. The belt is raised to give a clear head room of 6 ft. where it crosses the gangways in order that these may be left open for traffic.

Considerable trouble has been experienced with the machine owing to the design, which experience has proved to be capable of considerable improvement. In spite of its defects the Postmaster of Manchester has reported very favourably upon it, and a large proportion of the total cost has already been saved by its use.

At the beginning of 1907 it was decided to again experiment with the facing table conveyor, and a design for an endless belt conveyor was prepared. The firm with whom the contract was placed suggested a small turn-table at the delivery end to collect the letters from the belt, and provide a small storage capacity to prevent defacement of the letters should the attendant neglect to immediately remove them. It is proposed to try this turn-table on a similar conveyor now being erected at Mount Pleasant. An arrangement for sloping the belt down to the table level, and fitting on the slope a balanced stop, which the letters themselves could push down as they accumulated, was tried; this was unsuccessful, it being found that the letters climbed upon one another as soon as the resistance due to the stop was encountered, and became disarranged.

The arrangement finally adopted was that of the original design, viz. carrying the belt right to the end of the table, the letters to be picked off by an attendant as they arrive. A stamping machine is placed at one end of the table, the letters being taken from the belt straight on to the table of this machine, where they are dealt with by the sorter in charge. The conveyor has an effective length of 20 ft., and the belt is of 3-ply canvas, 9 in. wide, about 44 ft. long, and designed to run at a speed of 16 to 32 ft. per minute, at a height of about 10 in. above the table top. The most satisfactory speed in practice has proved to be 16 ft. per minute, and after various minor improvements the conveyor is now giving satisfaction. During the same year an entirely different method was suggested, consisting of a belt running on vertical rollers, and provided with small suitably shaped pockets or trays, into which the letters might be placed. A stamping machine was to be placed at each end of the facing table, in order to fully utilise the advantages of this form of conveyor. With such an arrangement the stamping machine attendant would be able to take off his own letters, and should more pass him than his machine could stamp, they would be allowed to go to the atten-

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dant at the other end, or to revolve until one or other of the machines were ready for them, as this conveyor, unlike the horizontal belt, has a large storage capacity.

An outline sketch is given in 1, 2, and 3, only the driving end of the conveyor being shown. The opposite end will, however, be similarly arranged, but without the driving gear, and with a smaller motor for driving the second stamping machine only. The size of the table to give the most efficient result should be 21 ft. by 5 ft.; the

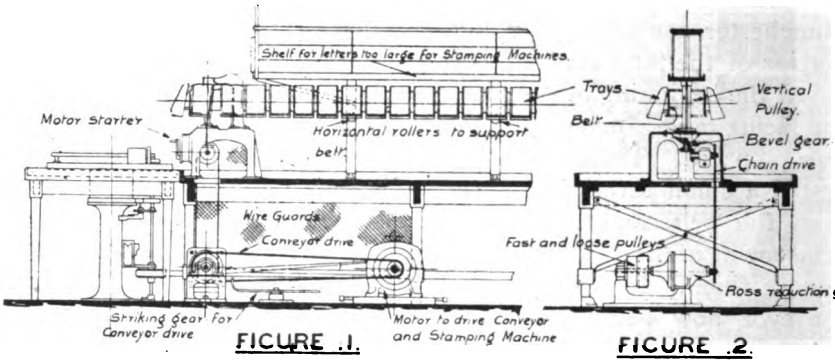

FIGURE .1. FIGURE .2.

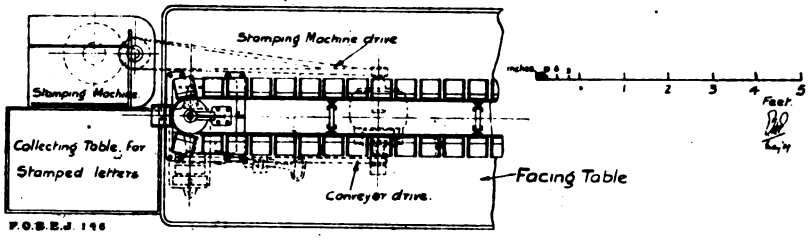

FIGURE .3.

1, 2, and 3.—Facing Table Conveyor.

over-all sizes, including the two stamping machines, would then be 28 ft. by 5 ft. It is not proposed to enter into a detailed examination of the relative merits of the various types of facing table conveyors, although it may be said that the horizontal belt only partially meets the need of the case, and in the opinion of the writer the final solution of the problem will probably be found on lines similar to those indicated by 1, 2 and 3, although this arrangement has not yet been given a practical trial.

In 1906–7 the question of equipping sorting offices with mechanical distribution was considered, with the result that two experimental conveyors, one of the endless belt type, the other an overhead runway, were installed in the letter-sorting office, Mount

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Pleasant. The belt conveyor runs from the packet-opening tables to the packet table in the North-Western Division, a distance of 155 ft., and is fixed throughout its length beneath the floor; the belt is of 10-ply cotton, 22 in. wide, 350 ft. in length, and designed to run at a speed of 180 ft. per minute, the joints being butted and stitched; the framework is of stout channel steel, hung from the floor beams. The bearings and rollers carrying the upper and lower portions of

4.—Delivery Table, Mount Pleasant.

the belt are fixed to the top and bottom flanges respectively of this channel frame. The packets are fed from underneath a packet table into a steel shoot, which deposits them on to the moving belt below. At the delivery end the belt dips suddenly, the packets sliding down a steel shoot to the lower level, and then rising with the belt and through the floor, at an angle of about 18°, discharging on to a delivery table sloped downwards in such a manner that the packets drop into a low basket. The arrangement of the delivery table and baskets, with packets coming up on the belt, is shown in 4.

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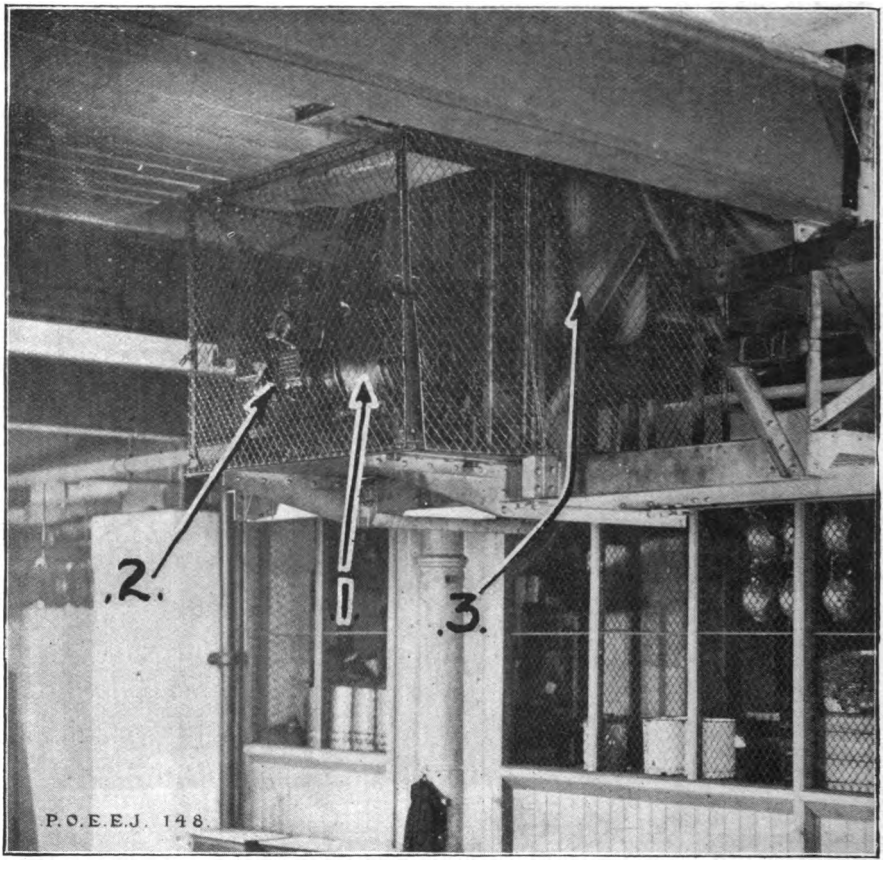
The motor, driving and tension gear, are located immediately under the delivery table, and are supported on a steel framework hung from the floor beams. The general arrangement is indicated by 5, not, however, very clearly, as it was necessary to take the photograph by flashlight, this part of the basement being quite dark. The following references will enable the various portions to be iden-



5.—Motor and Gear—Hung from Ceiling.

tified: (1) Motor, 3 brake-horse-power; (2) worm gear; (3) tension gear. It will be noticed that the gear is completely enclosed by wire mesh guards. At the top right-hand corner of 5 one of the rollers supporting the return half of the belt is seen just where the conveyor rises through the floor. The starting switch, fitted with overload and no-load releases, is fixed on the end of the table immediately above the loading shoot, and two emergency push-buttons, by which the no-volt release may be short-circuited, are provided

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for stopping the conveyor in case of need. One is placed by the starting switch, the second is seen in **4**, together with a small engraved plate explaining its use, fitted on the end of the newspaper sorting table. An interesting feature of this installation is that the belt is not in a straight line throughout its length, but at the point of dip it is deflected horizontally for nearly 5° by setting the four rollers used at this point, the twist on the belt being neutralised by deflecting the two rollers carrying the upper portion to the left, and those taking the lower to the right. The overhead conveyor is taken from the bag-opening tables to the bundle-opening table in the North-Western Division, and has a straight run of 170 ft. The runway joist is suspended by means of cast iron hangers from the ceiling beams. A double carriage of the monorail type is provided, running upon a tramway rail fitted to the top flange of the joist; this carriage takes the two motors, each of ½ break-horse-power; both motors are provided with electro-magnetic brakes. The current is collected from two trolley wires, running by the side of the supporting joist and controlled from the main switchboard.

The running motor drives the track wheels of the carriage through gearing, the hoisting and lowering motor, its speed reduced through worm gearing, working a double rope hoist, fitted with two steel ropes. The skep itself is of wicker, well protected, approximately 1 ft. 6 in. by 1 ft. 6 in. by 2 ft. 6 in. deep, and will carry a load of 50 lb.; it is attached to the wire ropes by means of steel pins and hooks. At the dispatching end the skep may be withdrawn from the frame guards for convenience in loading. Hinged flaps, with a spring lock, are fitted to the underside of the skep, so that on the withdrawal of the lock the flaps may open and the contents drop on to the table provided for cutting open the bundles. Steel frame guards are provided from floor to ceiling to enclose the skep during the raising and lowering process, and are fitted with oak guides to prevent it swaying when entering the frames. The controlling gear is extremely complicated, the electrical portion consisting mainly of cams, controlled by solenoid-operated and spring-restored pawls. The first operation, viz. setting the controller for raising, is mechanical, and is performed by means of a lever worked from the ground level by a chain; the remaining movements are entirely automatic. The cycle of operations is as follows: Upon loading, the starting lever is set and the skep raised to the running level, where the hoisting motor is cut out and the running motor switched in; on the arrival of the carriage at the delivery end it is steadied by the oak guides, and at the same moment the running motor is switched out of circuit, the lowering motor switched in and the skep lowered, but at this end only to within two feet of the table top, and not to the ground. The bundles are then discharged as previously explained.

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The whole of these operations are repeated in order to send the empty skep back to the dispatching end. The carriage and skep travel at an average speed of 350 ft. per minute, and they make from twenty-two to twenty-five journeys per hour.

Very considerable trouble has been experienced with the runway, due to its complicated control gear. Both this and the endless belt conveyor have had an extended trial, and the result has been to demonstrate the immense superiority of the endless belt type for sorting office distribution, not the least advantage being its freedom from complicated mechanism and absence of need for repairs and constant attention. As a matter of fact, with a well-constructed conveyor of this type the average attendance, including slight repairs, should not exceed half an hour per day.

(*To be continued.*)

INDEXING.

By H. NORTH.

"I for my own part venerate the inventor of Indexes."
ISAAC DISRALLI, *Library Miscellaneous.*

THE qualities requisite in a good indexer are intelligence and conscientiousness based on a thorough all-round education and backed by sound methods of work. The only way to insure good work is to have a definite method of work and never slur over or depart from it, for it must be remembered that while the indexer knows all about the case he is dealing with those who may have to subsequently refer to it may know very little. The soul of indexing is brevity, but in an index nothing must be left to the imagination. An *entry* is the unit of an index; the records of a single thing contained in the file. An imperfect entry is worse than omission; the latter disappoints, but the former misleads. A *heading* is the generic term under which specific entries are generally arranged and to which they all refer. Edgeworth's 'Essay on Irish Bulls,' and a 'Treatise on the Great Seal,' have been indexed under the heading of "Zoology," and 'Ruskin's Notes on the Construction of the Sheepfolds' under "Agriculture." A little common sense should enable the indexer to select the correct heading, provided the headings are sufficiently distinct to prevent undue overlapping.

The selection of suitable subject headings is of the utmost

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importance, and whilst they must necessarily vary with the different classes of work to be dealt with, they should be brief but distinct. The number should be limited to the smallest dimensions consistent with clearness, and should in no circumstance contain such headings as "General" or "Miscellaneous," for under "General" or "Miscellaneous" may be included each and every item.

Having decided upon your headings take sheets of stout paper and divide the upper edge into as many parts as you have headings, cut away or step the sheets so as to leave a section of each visible, and print the headings you have decided upon alphabetically on the exposed portion.

On each sheet enter the sub-heads to be included, and under each sub-head the items themselves.

In framing the sub-divisions or entering the various items, it is best to first pencil them on separate rough slips before entering them on the headed sheet, then sort them into the respective sub-heads as each slip is written, and finally sort them alphabetically before copying. The slight loss of time incurred in turning up a certain sheet to place the rough notes in their proper subdivision is amply repaid by the enormous saving effected in the final revision and sorting. Scarcely any editing is required, and repetition is almost completely avoided. Unless extreme care is taken, however, confusion arises from accumulation of sub-headings. They should be written in at intervals on the subject sheet to allow for additional entries, as the simple addition of extra sheets to the headed or subject sheet provides for an unlimited number of entries.

In setting out the sub-headings there is no better way than by careful indentation of sub-entries and entries subordinate to these, and no worse way than by "running on" the sub-entries and those further subordinate in one column, which causes much confusion of understanding.

An index, for example, for the Engineer-in-Chief's Headquarter Office framed on these lines might take for the master key the respective divisions into which the British Isles are divided. Each division or district would then be marked alike as regards subject headings, as uniformity of indexing is essential, so that each separate index should read into every other index and act correlatively, and might be divided into the following: (1) Accounts, (2) Circuits, Building, etc., (3) Electric Light and Power, (4) Public, (5) Staff, (6) Wayleaves. The sub-headings would be:

Accounts, all classes of payment, such as:

Advertisements,
Allowances,
Cartage,
Contracts,
General work,
Reinstatements,
Royalties, etc.,

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Circuits,[1] buildings, etc.: All matters affecting circuits, buildings, stores, apparatus, etc., other than electric light and power and wayleaves, such as:

Accommodation, temporary,
Coast-guard circuits,
Exchange circuits,
Extensions,
Government circuits,
Junctions,
New buildings,
Post Office removals,
Private wires,
Rearrangements,
Stone-throwing,
Trunks, etc.,

Electric light and power:

Boilers,
Fans,
Fire protection service,
Heating,
Hydraulics,
Lifts,
Lighting,
Pneumatic tubes, etc.,

Public:

Acts of Parliament,
Bills, proposed,
Complaints, etc., not affecting other subject headings

Staff:

Absence,
Annual leave,
Enforced leave,
Sick leave,
Special leave,
Accidents to staff,
Allowance to staff,
Appointments,
Certificates, sick,
Clothing, protective,
Examinations, technical,
Extra duty,
Increments,
Promotions,
Resignations,
Transfer of staff,
Uniform, etc.,

Wayleaves:

All wayleave matters, including Canal, Railway, and National Telephone Company.

Each of these sub-heads can be further subdivided according to requirements, as shown under "Staff, absence." It only remains to letter and number each heading to complete the index. This may be done in two ways. The subject may take block or capital letters, S = Staff, and the sub-headings small or italic letters, a = absence, followed by numbers, thus: S/a/3, = Staff, absence, sick. The instruction or file required would be the third in the "a" compartment of the Staff file; or the decimal system introduced by Melvil Dewey may be employed:

5 = Staff.
5.10 = Staff, Absence
5.11 = ,, ,, Annual leave.

[1] From an engineering point of view "Circuits" covers nearly everything, and would be divided into Overground and Underground in some sections and subdivided under each.

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5 = Staff.
5.12 = Staff, Absence, Enforced leave.
5.13 = ,, ,, Sick leave.
5.14 = ,, ,, Special leave.
5.2 = ,, Accidents to, etc.

Cross references are frequently necessary and should act as links between (*a*) co-ordinate subjects (*b*) generic and specific headings, and (*c*) correct and incorrect headings. Care must be taken not to cross-reference in a circle, but direct to where the reference is to be found; never cross-reference to a reference.

Of the various so-called systems now before the public, probably the card index system is the most popular. The reputed inventor of the card index system was Abbé Rozier, who, it is stated, edited the general index to the publications of the Paris Academy of Science covering the years 1666–1770.

The plan of keeping cards or slips on edge in books or drawers loosely, thereby giving unlimited means of expansion and intercalation, must have occurred to many minds as the best means of maintaining perpetual alphabetical order. The beautiful cabinet work on show is not a system, and beyond providing compartments of a variety of dimensions and so precluding the possibility of the office boy placing the twelve inch card in the six inch slot, is not essential.

Whatever style of indexing is chosen, be consistent. A change of method cannot but be dangerous, and inconsistency must seriously diminish the value of an index, no matter how excellent it may be in other respects.

If those responsible for indexing would but recognise the importance of merging each set of items roughly indexed into its predecessor there would be less anxiety when the time arrives to revise a general index.

NEW IDEAS.

In this section we publish quarterly, by kind consent of Major O'Meara, Engineer-in-Chief to the Post Office, details of new ideas which have been adopted, or are under trial by the British Post Office.

A New Distributing Box for Telephone Circuits.

Owing to the number of pipes and cables in many of the London footways, it is becoming difficult to adhere to the recognised method for the distribution of telephone subscribers' circuits by means of flush boxes. It is frequently found impossible to find space for the

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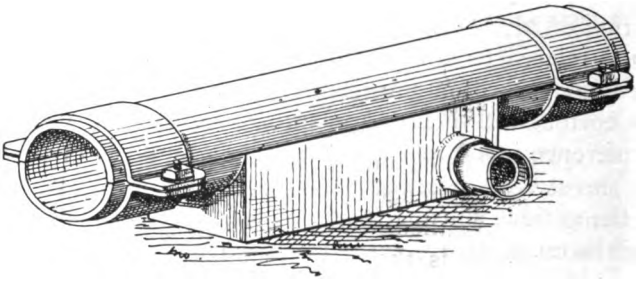
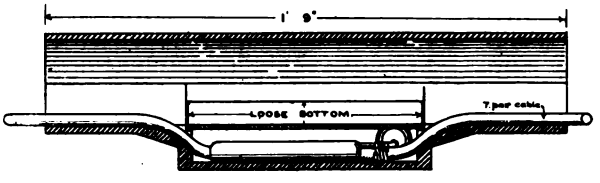
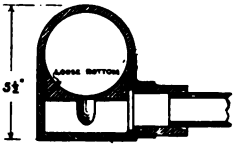
construction of a distribution box opposite the entrance to the premises to be served, and the box has, therefore, to be placed some distance away on the line of pipes. In some cases this involves



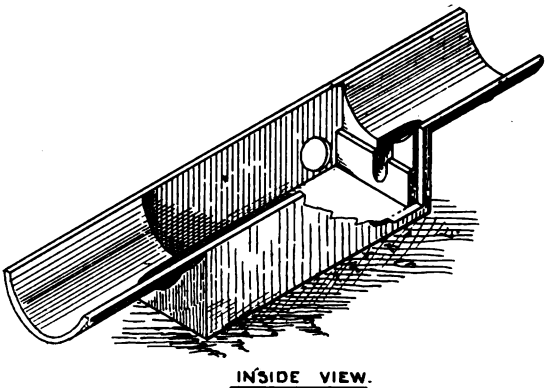
SIDE VIEW.



LONGITUDINAL SECTION



CROSS SECTION



INSIDE VIEW.
WITH LOOSE BOTTOM REMOVED

P.O.E.E.J. 138.

running service-pipes twelve or fifteen yards long, and the charges for reinstating in these circumstances have become a serious item, especially since patent stone-paving has come into general use in most of the boroughs. As a rule there is sufficient space to lay a three-inch pipe, and distribution could be arranged for by adapting

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the ordinary split coupling to take a distributing joint, but when additional seven-pair cables are required the street would have to be opened where the couplings are fixed. In order to overcome these difficulties a distribution split coupling has been introduced, on the suggestion of Mr. J. Hardie, and is now under experimental trial by the Department. This coupling is fitted with a special box or pocket designed to accommodate a "parallel joint" and the service pipe and cable. The cover of the pocket forms a loose bottom for the pipe, and serves the purpose of protecting the joint, while it allows the sweeps' rods to pass freely, and permits of additional cables being drawn into position over it without injury. Illustrations of the coupling are given by means of a side view, a longitudinal section showing the parallel joint in its position in the pocket, and a cross-section and inside view.

While the fitting was primarily designed for use in congested footways, it might be used with advantage and economy in thoroughfares where roadway boxes are at present built on distribution pipes.

NOTES AND COMMENTS.

Telephone Distribution Methods.

The short article by Mr. Steed on the above subject will probably give rise to thoughts in the minds of our London readers.

There can be no doubt that in the City the Department's "all underground" system has proved entirely satisfactory.

In the West End, where the houses are large and the distribution dense, the same method was found peculiarly suitable. It had two special advantages. In practically every case the telephone is fixed in a room at the front of the house or in the hall, so that access from the front cheapens the wiring; and owing to the fact that such houses have sculleries and coal-cellars extending under the footways, it is frequently possible to drop from the side of the distribution box straight into the subscriber's premises, so avoiding the heavy charges for reinstating pavement when its disturbance is necessary.

When the original pipe-routes were laid liberal provision of distribution points was made for future years, and the advantage of this forethought is now being reaped. At the same time it will be noted from our "New Ideas" section that a praiseworthy effort is being made to avoid expense in cases where distribution is required at points awkwardly situated.

In "mean streets," however, the distribution problem is entirely

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different, and, as Mr. Steed suggests, its economical solution is very largely dependent on the personal equation of the engineer.

Access to one subscriber's premises is frequently obtainable most easily through the premises of another subscriber. In putting such an easement on a proper footing it makes all the difference whether the applicant explains to the grantor that the wayleave form is to enable him to protect *his* rights or to enable the Department to protect itself.

We will say nothing here as to the alternative "National" and Departmental methods of dealing with open-work distribution because we wish to invite some expressions of opinion from our readers. The discussion of the subject would be enhanced in value if some of our many "National" subscribers would accept this invitation.

THE ANGLO-FRENCH TELEPHONE CABLE.

THE intention of the Department to lay a cable fitted with loading coils across the English Channel is a matter which is not only of great interest but is of very great importance, as, if successful, it will largely help to a solution of the difficulty of obtaining direct telephonic communication with certain parts of the continent which are at present inaccessible in this respect. It will probably be possible, by means of the loading coils, to increase the speaking value of the cable more than threefold. The problem, both of construction and maintenance, is undoubtedly a difficult one, and it is not too much to say that its success (which is hopeful) will mark an era in telephonic progress, and would be looked upon as a very great scientific feat. Experiments have proved that not much is to be hoped for in the direction of increasing the speed of telegraph signalling on cables by the use of loading coils, and it is believed that considerable misunderstanding exists on this point amongst many telegraph engineers. The actual improvement possible by the use of loading coils (in the case of telephonic transmission), also, is a matter on which there is much want of knowledge. Up to the present experiment seems to prove that an improvement of about three to three and a half times in the case of a cable is as much as can be expected, and it is doubtful if this amount is likely to be greatly exceeded. In the case of loading coils for cables an all important matter is high efficiency with smallness of bulk, and there is room for much research in this direction. It does not appear to be generally known that the quality of the iron wire used in forming the coils is not at all in accordance with what, at first sight, might be thought to be the right kind, *i.e.*, soft iron charcoal wire is highly inefficient, wire of the nature of steel being best; further research in

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this direction would probably be highly profitable, as high inductance with low "effective resistance" and small bulk in the coils is, of course, the crux of the problem.

The Telephone Situation in Paris.

The article by Mr. Kennedy which appears in the present number of the JOURNAL will enable our readers to appreciate the magnitude of the emergency through which our French friends have passed, and also, we hope, to draw some inferences of much value regarding the precautions necessary in order to guard as far as possible against occurrences of this calamitous nature.

Object lessons of so striking a character throw a fierce light upon weak points, and make it very easy to be wise after the event. In such circumstances it is necessary to criticise with calmness and to endeavour to concentrate attention upon the really vital points of the case.

The natural tendency to rush into the adoption of every conceivable safeguard in future construction may easily, unless tempered with due discretion, result in over-elaboration, which is not only cumbrous and costly in itself, but will bring with it a harvest of new troubles.

There seems, unfortunately, to be a strong natural antipathy between fire-resisting qualities and the qualities of electrical efficiency, and Post Office engineers will not readily forget the somewhat bitter experiences through which our own Department has passed in the highly meritorious endeavour to replace the inflammable wiring in use a few years ago by "flameproof" wiring.

There is no denying that the arrangements in existence in Paris before the fire were open to grave objections in many respects, but the manner in which the reconstitution of the system has been tackled by the French engineers is sufficient to show, if any such demonstration were necessary, that whatever the defects of the previous system may have been, they were not due to any lack of enterprise or ability on the part of the staff.

INSTITUTION NOTES.

COUNCIL NOTES.

MEETINGS of the Council of the Institution of Post Office Electrical Engineers have been held at Worcester and Monmouth during the past quarter.

Mr. A. J. Stubbs presided at both meetings.

A considerable amount of important business was dealt with, and, from the volume of business transacted, the following items of general interest have been extracted.

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Library Catalogue.

A new catalogue of the Central Lending Library has been compiled and issued to members of the Institution. The catalogue contains several unique features, chief among these being a brief synopsis of the contents of each of the books in the library. This arrangement will prove of material assistance to readers desiring information on the scope of any particular volume.

Free Postage.

It is interesting to report that Treasury authority has now been received for the continuance of the privilege of free postage in respect of library books and technical periodicals, where these are not circulated through the official pouches.

Professional Papers.

Two additional papers, read at local centre meetings during the past session, have been authorised for printing, viz.:

"Underground Construction." Mr. G. H. Comport. (Abstract of paper read at Scotland West Centre.)

"Alternating Current Measurements." Mr. A. G. Lee, B.Sc. (Paper read at Northern Centre.)

Lantern Slides.

Requests are occasionally received from local centres for the loan of lantern slides prepared for Institution lectures, and the Council have arranged to house the slides at the Central Library and to issue a contents slip for insertion in the library catalogue, giving particulars of the slides available for loan.

Resignation of Librarian.

Mr. T. Smerdon has resigned his position as Librarian to the Institution, and Mr. J. Smerdon has been appointed in his place.

Assistance to Members Preparing for Examinations.

A Committee of the Council has been appointed in order to prepare a series of useful notes and formulæ upon "Applied Mechanics" and "Theory of Structures" for use in preparation for Civil Service examinations for Second Class Engineerships.

The Council hope to issue the notes in a convenient form at an early date.

New Local Centre.

Steps have been taken to form a separate centre for the new South Western Engineering District.

LOCAL CENTRE NOTES.

METROPOLITAN CENTRE.

The annual meeting of the Council closed the winter session of the Institution in the metropolis, and the Local Centre Committee now has in hand the programme of meetings during the coming winter evenings.

The local libraries have been freely used during the past session, but the present opportunity may perhaps be taken to remind members that these libraries are available for several valuable and interesting books of reference.

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METROPOLITAN (SOUTH) DISTRICT.

"METSO" SPORTS CLUB.

The last of a very successful series of Whist Drives held during the winter session 1908–9 took place on the 3rd April last, at Stanley's Hall, Clapham Junction. On this occasion the prizes were distributed by Mrs. Alex Moir.

The Club has decided to institute a Lawn Tennis Trophy in the form of a Silver Cup, the holder for the year and the runner up to be presented with medals. Tournaments are now in full swing, and the interest in the games indicates a very close struggle for the possession of the cup. The *al fresco* teas on the lawn are very much appreciated.

A 33 yards swimming handicap took place on May 27th at Wandsworth Baths. The winner was Mr. Horsey, Messrs. Brewer and Robinson being second and third respectively.

A Swimming Team Race with the Board of Agriculture, held at the same place on the 2nd June, resulted in a win for the "Metso" with three seconds to spare.

NORTH-WESTERN DISTRICT.

The last meeting of the 1908–9 Session was held on the 22nd March, when a paper on "The Manchester Trunk Exchange" was read by Mr. R. Lawson. The paper was suitably illustrated by lantern slides.

CHESS CLUB NOTES.

READERS of the Chess Notes will doubtless remember that the final score of the Chess Club in League matches was 7 games won, 1 drawn, and 1 lost. This score gave the Club second place in the League, and with it, second prize. The prize took the form of five sets of chessmen.

It was hoped to publish in this issue the results of the Club Championship and Handicap, but, unfortunately, neither is finished. Both competitions have been closely contested, the Handicap particularly so, ties having occurred in three of the four sections. In addition, there have been many drawn games, and it is mainly due to these that a definite result has not been arrived at.

The Annual Supper, which was held at the Hotel Previtali, W., on April 20th, proved, as usual, a most enjoyable function. In the unavoidable absence of our President, Major O'Meara, C.M.G., the chair was taken by Sir J. Gavey, C.B. Included among the visitors were Major G. B. Roberts, R.E., and Messrs. W. H. Allen, T. Harrison, J. F. Lamb, I. Probert, E. W. Rees, J. W. Willmot, and W. H. Winny.

An excellent supper was followed by a musical programme, which proved much to the taste of those present. The artistes were: Miss Jessie Reeve (Soprano), Mr. W. E. Glendinning (Tenor), Mr. E. A. Pink (Bass), Mr. Roland Merry (Humorist), and Mr. B. M. Brown (Violin solos). Mr. R. Myles Hook proved an able and sympathetic accompanist.

The speeches were not by any means the least enjoyable part of the proceedings. A story told by the Chairman bore eloquent testimony to the great value of chess as a reforming agent, and those non-chess players who heard the story will, it is to be hoped (unless they have been reformed by other means), not only join the Chess Club themselves, but will also persuade others to do the same.

The toasts proposed were:

Toast.	*Proposer.*	*Reply.*
"The Chess Club" ...	The Chairman ...	The Hon. Secretary.
"The Visitors" ...	Mr. W. Noble ...	Mr. W. H. Allen.
"The Chairman" ...	Mr. A. Moir ...	The Chairman.

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LAWN TENNIS MATCH.

ENGINEER-IN-CHIEF'S OFFICE *v.* METROPOLITAN (SOUTH) ENGINEERING DISTRICT.

This match was played at Ealing, on June 16th, and resulted in a victory for the Engineer-in-Chief's Office by 5 events to 2, 13 sets to 7, 108 games to 80. Two matches were left unfinished. Scores:

H. W. Fulcher and E. H. Walters beat E. E. Mullens and J. E. T. S. Hilton 6—2, 6—0; beat T. L. Robinson and W. G. Restall 6—1, 6—2; and beat A. T. Restall and R. Purves, 6—3, 6—0.

D. H. Kennedy and A. E. Thorne lost to Robinson and Restall 10—8, 2—6, 3—6; beat Restall and Purves 1—6, 7—5, 6—2; and the event with Mullens and Hilton was left unfinished at 4—6.

A. H. Shepperd and S. E. Rishworth lost to Mullens and Hilton 6—4, 4—6, 4—6 beat Restall and Purves 6—0, 6—4; and the event with Robinson and Restall was left unfinished 7—9, 6—4.

BOOKS RECEIVED.

THE LIFE STORY OF SIR CHARLES BRIGHT,

WITH WHICH IS INCORPORATED THE STORY OF THE FIRST TELEGRAPH TO AMERICA, INDIA, AND THE COLONIES, BY CHARLES BRIGHT, F.R.S.E. Price 12*s.* 6*d.* net. Archibald Constable and Co.

Published in the year of the fiftieth anniversary of the Atlantic cable, this book is a revision and abridgement of the larger and more costly work which in 1898 was welcomed as a fitting memorial of one of the earliest, most popular, and most eminent of electrical pioneers.

Born in 1832 Bright lived in stirring times. We rub our eyes and look again as we read how he devised new inventions at seventeen, laid an underground system in one night at Manchester at nineteen, became chief engineer of the Magnetic Company at twenty, and was knighted for successfully laying the first Atlantic cable at the age of twenty-six.

Narrated by his son, and with pardonable pride, the story of Charles Bright has much of interest for the general reader, and will prove intensely interesting to the modern telegraph engineer.

Owing to his father's pecuniary losses Bright escaped an Oxford career, and had to enter on the practical side of life at the age of fifteen.

The reader with a mathematical bent may here enter into calculations as to the gain to international telegraphy which may be set against those lost university years.

Starting as a telegraph clerk at Harrow, Bright soon commenced to devise improvements, and as patent fees were too high he, with

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his brother, accumulated twenty-four inventions and included them in one patent in 1852.

The most important were the porcelain insulator, the shackles (many of which are still in use), the brass tape device for protecting submarine cables, and a translator—a wonderful achievement for two youths of twenty-one and twenty years respectively. In the same year Charles Bright was responsible for the laying of 7000 miles of underground wire, connecting points so remote as London, Liverpool, and Glasgow, and in Ireland, Belfast and Dublin with many intermediate points.

Full and interesting details of these achievements are given, and they should be read by the engineer of to-day, so that when he digs up a section of the 1852 "underground" he may at once recognise it and be carried back in imagination to those early telegraph days when it was put in position under the guidance of this energetic and youthful pioneer.

A large section is given to the Atlantic cable, but it is eclipsed in interest by the stories of cable laying in the West Indies, where coral bottoms caused breakages and rendered recoveries so difficult as only to be conquered by months and months of perseverence against heart-breaking discouragements.

It was here that Sir Charles was attacked by malarial fever, the recurrence of which ultimately caused his decease at the comparatively early age of fifty-six.

The book is well printed and illustrated, and we can with confidence recommend its perusal to our readers.

'Questions and Solutions in Telegraphy and Telephony,' by H. P. Few. S. Rentell & Co., Maiden Lane, W.C. 2*s*. net.

Students preparing for the City and Guilds examinations in the ordinary grades of telegraphy and telephony will find in this little work a reliable guide to the form of answer which best contributes to the award of high marks. The author, himself a silver medallist in honours telegraphy, answers all the ordinary grade questions set during the five years ending 1908. Some of the answers have been given rather more fully than would be required of a student in the time allotted by the examiners, but this will be regarded as a merit rather than a defect.

Very few technical works are free from inaccuracies in their first editions, and we cannot, unfortunately, regard this as an exception. So far as can be seen from a rapid perusal of the book, the following are the more important errors which have been made:

To the question "How may the electro-motive force of a battery be increased?" on p. 4, no direct answer is given.

In Fig. 11 the end of the multiple should be left open.

In the answer to question 12, p. 54, the connections of a 5-terminal

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key for marking and spacing are shown reversed, and the connections of a 4-terminal key are also given inaccurately, so that the whole answer fails to carry conviction.

In the sketch of a strutted pole, p. 62, the strut is shown secured to the pole by means of a scarf-joint with two bolts and nuts instead of one.

The answer to the question upon the intermediate switch of a three-station metallic circuit, p. 75, wrongly describes the conditions obtaining in the three positions of the switch, and is also in error as regards the function of the bell across terminals 3 and 7.

The diagram of the central battery telegraph circuit, shown in Fig. 74, is not accurate as regards the point at which other circuits working from the same battery are connected.

In spite of the minor defects referred to above, we can recommend the book as a useful supplement to the larger and more regular treatises on telegraphy and telephony. The definitions of electrical terms scattered about the book are accurately given, and the numerical examples, of which there are many, are correctly worked. Most of the answers are given in model form, and they contain a large fund of condensed information. The book is of handy size, the paper is good, the type and diagrams are clear, and the general get-up is commendable. We may assert with confidence that this book will be welcomed by the large army of workers in telegraphy and telephony, as well as by teachers in those subjects.

'The Telegraphist's Guide,' by Bell & Wilson. S. Rentell & Co., London, W.C. *2s.* net.

The new edition of this book contains a considerable amount of new matter which will be of value to telegraphists. Illustrated descriptions of the Purves C.B. duplex, the Hay C.B. duplex, the Vyle and Smart C.B. duplex, the Central Telegraph Office intercommunication switchboard, the Vyle polarised sounder, the working of C.B. omnibus circuits, together with the quadruplex and split quadruplex repeaters, have been added, and eleven of the old illustrations have been displaced by more modern ones. It is a pity that Fig. 50 was not included in this process. The cross-over wires from the rear terminals of the S.N. commutator terminate on the wooden handles. Little slips of this kind form mountainous difficulties for the lonely student. It is fair to add that this is an exceptional case. The book is undoubtedly useful and very cheap.

'The Telegraphist's and Telephonist's Note-Book.' S. Rentell & Co., Ltd., 36, Maiden Lane, Strand, W.C. Pp. 120, *1s. 6d.* net.

Although all the subjects included in the contents of this book do not bear directly on the practical work of the telegraphist and telephonist, yet they will doubtless all be appreciated by the serious student. Conciseness and lucidity have been aimed at throughout the book, but the sections dealing with primary and secondary cells, Ohm's law, the magnetic circuit, the balancing of duplex and quadruplex circuits, and the electrical transmission of speech deserve

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special mention. The section on relays includes a description of the old type of polarised sounder, but omits any mention of the new type; this mars an otherwise excellent section.

The size of the book is extremely convenient for the pocket.

POST OFFICE TECHNICAL INSTRUCTIONS.

WE number among our readers many who do not receive official copies of the 'Technical Instructions,' but who are keenly interested in the technical side of the Department's work. To such it may not be generally known that certain of the 'Technical Instructions' are now on sale to the public at a nominal price.

'Technical Instruction XIII,' which deals with the construction of aërial lines, is sold at 1*s.* 3*d.*

'Technical Instruction XIV,' which deals with the construction of underground telephone and telegraph lines, is sold at 1*s.* 6*d.*

The latter has only just been issued. It is bound in stiff covers, and contains over 90 pages of matter and 115 illustrations. All the operations involved in underground work are dealt with fully and clearly, and the volume will be found of considerable assistance to students and to officers of other administrations, as well as to those for whom it is primarily intended.

The 'Technical Instructions' may be purchased directly, or through any bookseller, from Wyman & Sons, Ltd., Fetter Lane, E.C.; Oliver & Boyd, Tweeddale Court, Edinburgh; and E. Ponsonby, 116, Grafton Street, Dublin.

CATALOGUES.

MESSRS. S. RENTELL & CO., LTD., have just issued a new catalogue of Books on Electricity of 32 pp. The list has been carefully classified, and this feature will make it of value to those wishful to widen their acquaintance with contemporary technical literature.

We note that there are 57 works on Telegraphy and 17 on Telephony. Verily the making of books continueth.

CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

"EXAMINATIONS."

DEAR SIR,—In your Editorial on "Sub-Engineers' Examinations" the opinion is expressed that: "In dealing with large bodies of *junior* officers examinations are necessary as tests of unfitness, and to prove the possession of a minimum equipment of mental tools." Apparently it has been overlooked that many of the *junior* (*sic*) officers concerned are about forty years of age!

Apart, however, from this consideration, a good subject has been provided for an interesting debate to which I should like to contribute the following extracts.

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Herbert Spencer, who was a *sub-engineer* on the London and Birmingham Railway, states in his 'Autobiography'—

"I never passed an examination, nor could I have passed any such examinations as are commonly prescribed. The very conception of such training implies a forcing of the mind into shapes it would not otherwise have taken, implies a bending of the shoots out of their lines of spontaneous growth into conformity with a pattern.

"It is astonishing how general among distinguished engineers has been the absence of education in the conventional sense of the word. James Brindley and George Stephenson were without any such instruction at all. Telford, too, a shepherd-boy, had no culture beyond that which a parish school afforded. Neither Smeaton, Rennie, nor Watt passed through a curriculum appropriate to the profession they followed. Franklin left school at the age of ten. George Simon Ohm was a locksmith and Michael Faraday was a bookbinder. Another piece of evidence, no less remarkable, is furnished by the case of Sir Benjamin Baker, who designed and executed the Forth Bridge, the greatest and most remarkable bridge in the world. He received no regular engineering instruction.

"Such men, who, more than nearly all other men, show constructive imagination, seem thus to prove by implication the repressive influence of an educational system which imposes ideas from without, instead of evolving them from within. The established systems of education are fundamentally vicious in their manner. They encourage submissive receptivity instead of independent activity. Everybody nowadays hears of the evils of 'cram,' and yet insistence upon them seems to produce no effect whatever. Though it has become manifest that the accumulation of knowledge in excess of power to use it is not only no aid to efficiency, but is an impediment to efficiency, yet the *quantity* of knowledge accumulated continues to be used as the measure of efficiency."

George Eliot, in 'Adam Bede,' expresses the same idea in somewhat different words:

"College mostly makes people like bladders—just good for nothing but to hold the stuff that is poured into them."

Professor Perry, in 'Practical Mathematics,' says:

"We ought to recognise the fact that the real study of an engineer's profession is not at school or college. Any child can state Newton's second law of motion and the other half dozen all-important principles of mechanics so as to get full marks at an examination."

From 'Chambers' Journal,' July, 1908:

"The examination system, which the Chinese are giving up after trying it for more than five thousand years, has come to our Army with intensity. The outlook of a young officer is a series of examinations. It is not because our officers are deficient in mental vigour that they dislike these ordeals. Indeed, many of them are fond of study, and pass examinations for promotion as well as in languages with great credit. They do not like, however, to have examinations held over their heads like a whip, and made to cause uncertainty and anxiety."

What the feeling of the Army is on this subject is exactly the feeling of all grades of the Engineering Department of the Post Office.

Mr. Edison, probably the most remarkable inventor who ever lived, is himself a self-trained man. Here are some quotations from an account of an interview with him which appeared a few years ago in the 'Speaker.'

"To my question as to where he found the best young men to train as his assistants he answered emphatically: '*The college bred ones are not worth a rap.* I don't know why, but they don't seem to begin at the beginning and give their whole heart to their work.'"

In a biographical sketch of the celebrated engineer, John Ericsson, is found the following significant passage:

"When a friend spoke to him with regret of his not having graduated from some technological institute, he answered that the fact, on the other hand, was very fortunate. If he had taken a course at such an institution he would have acquired such a belief in authorities that he would never have been able to develop originality and make his own way in physics and mechanics."

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The case was admirably summed up in an article which recently appeared in the 'Electrical Review.' The writer contended that the examination system was boomed by the class who were able to pay the cost of University education in order to corner the more lucrative positions for themselves. It was also boomed by professors and others with vested interests, and it was only tolerated by the *bourgeoisie* owing to their innate love of gambling—they loved to watch for the result of an examination as others did for the result of the Derby.

The following is an extract from 'Success in Life' (Emil Reich):

"Another delusion, and one that as a nation we put pathetic faith in, is our infinite credence in the possibilities of education. One of the many disconcerting commonplaces of history is the fact that in countless cases success has been won by uneducated men. Indeed, it might be plausibly contended that the highest success in nearly all departments of life has been achieved by men of this type. Take literature for example, we have instances like Bunyan, Dickens, and Shakespeare. Take war, politics, invention, and the sphere of public affairs, what greater names could be brought forward than that of Napoleon, Marlborough, Nelson, Franklin, Lincoln, Stephenson, Rhodes Yet it is doubtful if one of these great men could have passed the London 'Matric.' at any stage in their career."

The recommendations made by a committee formed to inquire into the question of engineering training includes the following ('Electrical Review,' May 18th, 1906):

"In connection with the granting of degrees, diplomas and certificates to engineering students . . . *degrees should not be granted on the results of terminal or final examinations alone.* . . .

"The Committee reaffirms the conviction expressed when they issued their inquiry, that the sympathy and assistance of employers is essential to improvement in engineering education and training."

Sir John Gavey, in giving evidence before the Hobhouse Committee, made the following statement:

"An officer may be a thoroughly good practical engineer, and yet he might not pass such a good theoretical examination as another man, who would not be such a good officer."

I need hardly mention that practically all the brilliant ornaments of the telegraph engineers' profession throughout the world have compassed their achievements without the advantages, or, shall we say, unfettered by the stereotyping influences of a "college" education.

In conclusion, I quote from a poem by Rudyard Kipling, in which St. Peter is supposed to be examining one Tomlinson:

"You have read, you have thought, you have spoke, he said,
And your race you now have run,
By the grace of the powers that gave you birth
Make answer, What have you DONE?"

ONE WHO PASSED.

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STAFF CHANGES.

BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

PROMOTIONS.

District.	Name.	Appointment.	Previous Service.
Met. S.	McIlroy, R.	Suptg. Engr.	Tel., Belfast, 1885; Jr. Clk., Engr. Dept., 1891; Clk., 1895; Tech. Offr., 1897; Asst. Suptg. Engr., 1903; Staff Engr., 1st Cl., 1907.
E. in C.O.	Eldridge, E. J.	Staff Engr., 1st Cl.	Tel., C.T.O., 1881; Jr. Clk., Eng. Dept., 1887; Engr., 2nd Cl., 1892; 1st Cl., 1899; Tech. Offr., 2nd Cl., 1903; Asst. Suptg. Engr., 1905.
Met. C.	Pollock, S. A.	Asst. Suptg. Engr.	Tel., Belfast, 1889; Jr. Clk., Engr. Dept., 1894; Clk., 2nd Cl., 1900; Staff Engr., 2nd Cl., 1902.
Met. N.	Elliott, J. R. M.	Asst. Suptg. Engr.	Tel., Newc.-on-Tyne, 1885; Relay Clk., Engr. Dept., 1891; Engr., 2nd Cl., 1896; 1st Cl., 1901; Staff Engr., 2nd Cl., 1903.
Met. S.	Gomersall, E.	Asst. Suptg. Engr.	Tel., Leeds, 1893; Jr. Clk., Engr. Dept., 1896; Engr., 2nd Cl., 1900; Staff Engr., 2nd Cl., 1904.
Ire. N.	Masaroon, R. G.	Asst. Suptg. Engr.	S.C. & T., Derry, 1882; Royal Engr., 1883; Engr., 1st Cl., 1904.
E. in C.O.	Lack, E.	Staff Engr., 2nd Cl.	Tel., Hull, 1882; Relay Clk., Engr. Dept., 1893; Engr., 2nd Cl., 1899; 1st Cl., 1906.
,,	Bailey, W. J.	Staff Engr., 2nd Cl.	Tel., C.T.O., 1885; Sub-Engr., 1896; Eng., 2nd Cl., 1899; 1st Cl., 1906.
,,	Batchelor, W. M.	Staff Engr., 2nd Cl.	Tel., C.T.O., 1885; Jr. Clk., Engr. Dept., 1892; Engr., 2nd Cl., 1900; 1st Cl., 1906.
,,	Weaver, R. A.	Staff Engr., 2nd Cl.	Tel., B'ham, 1890; Jr. Clk., Engr. Dept., 1893; Engr., 2nd Cl., 1900; 1st Cl., 1907.
N.E.	Gray, A.	Engr., 1st Cl.	Tel., Newc.-on-Tyne, 1888; Relay Clk., Engr. Dept., 1896; Engr., 2nd Cl., 1901.
N.	Kitchen, H.	Engr., 1st Cl.	Tel., Newc.-on-Tyne, 1889; Relay Clk., Engr. Dept., 1897; Engr., 2nd Cl., 1901.
Sc. W.	Richardson, J.	Engr., 1st Cl.	Tel., Glasgow, 1885; Clk., Engr. Dept., 1895; Eng., 2nd Cl., 1901.
S. Mid.	Hill, J. G.	Engr., 1st Cl.	S.C. & T., Sheffield, 1882; Jr. Clk., Engr. Dept., 1896; Engr., 2nd Cl., 1901.

RETIREMENTS.

S. Wa.	Vyle, W. W.	Suptg. Engr.	E.T. Co., 1866; P.O., 1870; Clk., Engr. Dept., 1873; Insp., 1885; Asst. Suptg. Engr., 1891; Suptg. Engr., 1861.
N. Mid.	Richards, W.	Clk., 1st Cl. (Prov.)	1874; Jr. Clk., 1878; Sen. Clk., 1886; Engr., 2nd Cl., 1892; Engr., 1st Cl., 1900; Clk., 1st Cl., Prov., 1904.

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DEATH.

District.	Name.	Appointment.	Previous Service.
Ire. S.	Cross, W. H.	Asst. Suptg. Engr.	1872; Engr., 1st Cl., 1893; Asst. Suptg. Engr., 1901.

TRANSFERS.

Name.	Rank.	District. From.	District. To.
Fossett, J. H.	Asst. Suptg. Engr.	Ire. S.	Sc. W.
Evans, W. M.	Asst. Suptg. Engr.	Ire. N.	Ire. S.
Sinnott, J.	Asst. Suptg. Engr.	Met. S.	Met. N.
Kinsey, A. T.	Asst. Suptg. Engr.	Ire. N.	S.W.
Sheldon, J.	Engr., 1st Cl.	S.E.	S.W.
Henshilwood, G.	Engr., 1st Cl.	Ire. S.	S.E.
Chapman, A. E.	Engr., 1st Cl.	N.M.	S.W.
Hunter, H. J.	Engr., 2nd Cl.	N.W.	S.W.
Lawson, C. G.	Engr., 2nd Cl.	E. in CO.	E. L. and P.
Reid, F.	Engr., 2nd Cl.	E. in CO.	E. L. and P.
Chittick, H. S.	Engr., 2nd Cl.	E. in CO.	S.W.
Statters, J. E.	Engr., 2nd Cl.	E.	E. in CO.
Robinson, C.	Engr., 2nd Cl.	Met. N.	E. in CO.
Timmis, A. C.	Engr., 2nd Cl.	E. in CO.	N.W.
Kann, J. H. C.	Engr., 2nd Cl,	E. in CO.	S. Wa.
Dunsheath, P.	Engr., 2nd Cl.	E. in CO.	E.
Perrin, E. S.	Engr., 2nd Cl.	E. in CO.	Met. S.
Cave-Browne-Cave, N. F.	Engr , 2nd Cl.	E. in CO.	S.M.
Dwyer, J. J.	Engr., 2nd Cl.	Ire. S.	S.W.
Finlayson, W. J.	Engr., 2nd Cl.	Ire. S.	Ire. N.
Pennington, W.	Engr., 2nd Cl.	Ire. N.	S.W.
Pratt, A. J.	Sub-Engr.	Met. C.	N. Wa.
O'Shea, P.	Sub-Engr.	Ire. S.	Ire. N.
Wildgoose, G. H. A.	Sub-Engr.	Ire. N.	N.W.
Woodhouse, M. D.	Sub-Engr.	Ire. N.	S.W.
Yule, J.	Sub-Engr.	S. Wa.	S.W.
Wynne-Jones, A.	Sub-Engr.	Met. C.	S.W.
Lancaster, T. S.	Sub-Engr.	Met. S.	Met. C.
MacDermott, C. N.	Sub-Engr.	E. L. and P.	E. in CO.
Day W.	Sub-Engr.	Met. C.	E. in CO.
McDonald, C. G. A.	Sub-Engr.	N.E.	E. in CO.
Hunter, G.	Sub-Engr.	Met. N.	E. in CO.
Schofield, G. H.	Sub-Engr.	Met. C.	Met. N.
White, H. W.	Sub-Engr.	S.M.	E. in CO.
Bowyer, G.	Sub-Engr.	Met. S.	N.W.
Partington, R. W.	Sub-Engr.	Ire. S.	S.E.
Field, A. W.	Sub-Engr.	Met. S.	N.W.
Weir, A. W.	Clk., 1st Cl. Prov.	Ire. N.	S.W.
Peck, H. W.	Clk., 3rd Cl. Prov.	Sc. W.	E.

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OBITUARY.

William Henry Cross.

We regret to have to record the death of William Henry Cross, which took place at Dublin on May 13th, 1909, after a brief illness from pneumonia following influenza.

A native of Nottinghamshire, Mr. Cross joined the service of the Post Office as a clerk in the Engineering Department in 1872, and was appointed second-class engineer at Edinburgh in 1883. He spent eighteen years of his official life in Scotland under the late Mr. Gibson, who held a high opinion of his abilities, and became assistant superintending engineer at Cork in 1901.

All over the south of Ireland Mr. Cross was well known to Post Office and railway officials, with whom he was at all times on the best of terms. Of a genial and sympathetic disposition, the keynotes of his character were openness and straightforwardness. About these qualities there was never at any time a shadow of doubt. In the broad and manly life of William Henry Cross, governed as it was by a high sense of loyalty and uprightness, there was no room for anything narrow or petty, nor had he any use for the devious or crooked.

By his death, at the age of 56, the Post Office has lost a valued servant who never spared himself in its service, his immediate chief a loyal, helpful and resourceful assistant, and his colleagues a trusted and respected friend. A. M.

COMMUNICATIONS.

All Communications should be addressed to the Managing Editor, P.O.E.E. Journal, 22, G.P.O. West, London, E.C.

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POST OFFICE EXPERIMENTAL WIRELESS TELEGRAPH STATION AT SOUTH STACK, NEAR HOLYHEAD, ERECTED A.D. 1901.

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HARVARD UNIVERSITY
DEPARTMENT OF ENGINEERING.

THE
Post Office Electrical Engineers' Journal.

THE EARLY HISTORY OF WIRELESS TELEGRAPHY.

By J. E. Taylor, A.M.I.E.E.

(*Continued from p. 87.*)

Early Post-Office Tests of System.—Recognising the probable utility of Marconi's proposals for purposes of communication with lightships, Sir William Preece quickly decided on thoroughly proving its capabilities in a series of trials. To his prompt and decisive action in the matter, and the timely assistance rendered to Marconi at this critical stage, the art of wireless telegraphy is more indebted than is generally admitted.

After some brief demonstrations over relatively short distances, in which the writer was closely associated, first from the roof of the North Building of the G.P.O. to the roof of the Savings Bank in Knightrider Street (now the Central Telephone Exchange) in June, 1896, where the reflector system only was tried, and again on Salisbury Plain in September of the same year, under the superintendence of Mr. H. R. Kempe and Mr. John Chapman, where signals were sent and received two miles with reflectors, and about one third of a mile by the elevated capacity arrangement, preparations for an extended series of tests, on both methods, on the South Wales Coast were put in hand. For the latter, tall masts 112 feet high and capped with large galvanised-iron drums supported on insulators, were erected at Lavernock Point near Cardiff, and on the island of Flatholm, 3·3 miles distant, in the Bristol Channel. These sites were selected in order to ascertain whether there appeared to be any likelihood of making use of the system for communicating with the fortress on the island. The metal drums at the mastheads constituted the elevated capacity areas of the system, and were connected by substantial insulated cable to the apparatus in the signalling cabins below. The "earth" connection was made by running six heavy bare copper wires, 600 lb. copper cabled together, over the cliff edges and along the beach into the sea. Some portions

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of the apparatus used in these tests had been slightly modified or re-designed in the engineering branch of the Post Office, but the general character of the appliances remained much in its original state. Complete receiving and transmitting sets had been put together in the Post Office workshops, and were further supplemented by improved sets which Mr. Marconi had made up privately, together with a number of coherers of his own special and personal construction. Among the special appliances obtained by the Post Office for these tests, a large Rhumkorff coil, capable of giving spark discharges eighteen inches long, was included. Pending the completion of the arrangements for these tests, Mr. Marconi had been privately pursuing his experiments on Salisbury Plain, with the aid of kites and small balloons for suspending the aërial capacities, the balloons and kites being covered with thin tin foil to render them conducting.

Early in May, 1897, the tests between Lavernock Point and Flatholm Island were seriously commenced, and Mr. Marconi succeeded in demonstrating the transmission of signals between the two places in the presence of Professor Slaby, who had been specially deputed to witness the trials at the instance of the German Emperor. At these trials there were also present Sir William Preece, Sir John Gavey, the late Mr. Matthew Cooper, Captain Kennedy, R.E., and the writer. The late Professor Viriamu Jones, of Cardiff University College, was also an interested spectator. By this time the "new telegraphy" had become a matter of some notoriety, principally through the agency of press notices and articles in periodicals.

Following on these demonstrations, tests were made which showed transmission across the Bristol Channel from Lavernock to Brean Down near Weston-super-Mare to be possible. The distance bridged was about nine miles, kites being used to obtain increased height of aërial capacity.

The results obtained furnished conclusive proof of the inherent possibilities of the system, though it was evident from the variable nature of the signals received that much patient investigation was necessary before a sufficiently reliable method could be evolved to be of real practical utility. Looking back on the system as it then stood in the light of present-day knowledge, the reasons for the uncertain operation of the method are sufficiently obvious. In the first place, a fundamentally wrong principle was introduced in the matter of interposing the coherer directly in the elevated capacity lead, because the filings coherer used interrupted the continuity of the oscillatory system for receiving, and should thereby have prevented free oscillations occurring. There were, however, two or three factors which mitigated the consequences of this serious

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error. The coherer was itself bridged by the local circuit for operating the Morse instrument and tapper through the relay. The relay coils were shunted by a non-inductive double-wound resistance, which acted as a condenser for high-frequency currents, and in series with these, directly connected to each terminal of the coherer, were two small high-frequency choking coils, about the construction of which Mr. Marconi had found it necessary to be very particular. These choking coils were for the avowed purpose of choking back the high-frequency oscillations, and so confining their operation in their full intensity to the coherer. Had they fulfilled this purpose completely the receiver would have failed to operate. As it happened, however, the choking coils, in series with the double wound resistance, formed an oscillatory system of sufficiently high periodicity to accord fairly well with the impressed oscillatory E.M.F., and the coherer itself became an "overflow" to the whole system. In further support of this contention, there is the fact that it was always found that much better results could be obtained if the receiver air-wire was very considerably lengthened so as to make it approximately double the length of the transmitter wire. This of course had the effect of tuning it much more closely to the impressed E.M.F., having regard to the fact that the coherer cut it off from the earth. For this reason reception on high air-wires supported by kites when transmitting from a relatively short air-wire and mast often gave very good results, which were wrongly attributed to the increased height of the conductor. On the face of it, however, such an arrangement was extremely inconvenient, involving as it did one aërial arrangement for receiving and another for transmitting. Moreover, it was quickly found that atmospheric electrical disturbances became much more pronounced, indeed, at times almost fatally so, with high receiving wires. Improvement was according sought, mainly in other directions.

The filings coherer, used exclusively at this time as a receiving device, as constructed by Mr. Marconi, calls for a little comment. The types of this appliance previously in use had not given evidence of any possibility of practical utility on account of their extremely capricious and erratic behaviour. Several points in their construction were insisted on by Mr. Marconi, chief among these being:

That all traces of moisture must be rigorously excluded during construction and the tube hermetically sealed.

Oxidation to be prevented or minimised by the use of a pure hydrogen flame for sealing and fusing in the platinum wire connections.

The tube to be exhausted of air to a fairly high vacuum.

The electrodes to be of silver with brightly polished surfaces on which a small trace of mercury was used.

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The filings to be of carefully sifted hard nickel, ensuring uniformity of size of particles, with a small pinch of silver dust admixed.

The gap between the surfaces of the silver plugs to be kept very small, generally about one millimetre.

Coherers constructed in accordance with these conditions, and with perfect cleanliness and great care, certainly showed a marked advance, both in sensibility and regularity of operation, over any type previously made One of the reasons for this result, if not the main, doubtless is that internal friction is reduced to a smaller amount, thereby ensuring that the particles will always lie in such a way as to distribute the pressure of their weight uniformly through the mass. The admixture of finely powdered silver probably serves as a conducting lubricant assisting to this end. At any rate, the claim made was that its presence in the proper amount increased the sensitiveness of the coherer. A close analogy undoubtedly exists between the proper construction of a coherer and that of a microphone to ensure efficiency and regularity of operation in both cases. Undue internal friction is a factor to be avoided in each, as it allows of the formation of unstable systems of particles with undue pressure along certain lines of the formation, and consequent strong electrical contact and inefficient operation. Properly constructed coherers show, in their quiescent state, under the application of a voltage of unity or thereabouts, no measurable or perceptible conductivity.

Following closely on the Bristol Channel experiments, Marconi visited Italy in July, 1897, at the special request of the Italian Government. The writer was privileged on this occasion to accompany him to Rome, where numerous indoor demonstrations were given, notably at the Quirinale for the special edification of the late King Humbert and Queen Margherita, both of whom showed extreme interest in and an intelligent appreciation of the apparatus. Mr. Marconi next conveyed his apparatus to Spezia for trial between a shore station and warship, when signals were successfully transmitted over sixteen kilometres.

At this period, it may be mentioned, Mr. Marconi was negotiating the sale of his patent rights in the invention to a group of financiers in London, with whom he finally came to terms in July, 1897, and a syndicate was formed from which has sprung the "Marconi's Wireless Telegraph Company" of to-day. With the formation of the syndicate came a termination of Mr. Marconi's association with the Engineering Branch of the Post Office in experimental trials.

Dover Experiments.—Meanwhile, a programme of trials having been formulated and prepared for by the Post Office, it was determined to carry out privately such part of the programme as was

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justified by the preparations already made. Accordingly tests were made with a fixed transmitting equipment at Fort Burgoyne, near Dover, and a movable receiving set connected up at various points in the direction of St. Margaret's Bay. Summarised briefly, the results obtained were as follows :—

LAW OF TRANSMISSION.—A series of carefully conducted tests established the fact that for simple aërial wires (elevated wire system) the distance bridged was approximately proportional to the products of the heights of wire at the two stations, provided always that the height at one station was not too greatly different from that at the other. Taking equal heights at both stations, the distance bridged is proportional to the square of that height.

UTILITY OF REFLECTOR SYSTEM.—Tests made with this system did not, at Dover, give very promising results, the maximum distance bridged being from 1½ to 1¾ miles. The undulating character of the land over which the tests took place was found to be an unfavourable factor of considerable importance. The best results could only be obtained when the beam of electric waves projected from the transmitting reflector was maintained throughout its traverse at a fair height above the surface of the intervening land. The divergence, too, of the beam of waves used to be found to be fairly considerable—very many times greater than is the case with the excessively short luminous or light waves. Tuning was not extremely, but yet quite appreciably marked. These results must not, however, be taken as definitely settling the fate of the Reflector System for all telegraphic purposes. Neither the appliances nor the time then at disposal were sufficient for exhaustive tests.

TUNING.—With the elevated-wire system, when no capacity areas were used at the tops of the aërial wires, no appreciable effects of tuning, syntony, or resonance, as it has been variously termed, were particularly noticeable. On the other hand, sufficiently marked tuning was at once appreciable on terminating the upper ends of the aërial wires on capacity areas of thin copper sheets four feet square. Two such sheets on one aërial and one on the other threw the systems out of tune, so that the distance which could be bridged was considerably reduced. Two on each, or one on each, gave results over the maximum distances. It was not considered, however, that a sufficient divergence could be obtained to make use of the effect in rendering contiguous pairs of installations non-interfering or "selective."

USE OF TESLA COILS OR OSCILLATION TRANSFORMERS.—These appliances, now so extensively adapted to the purposes of wireless telegraphy, were first actually tried in the Dover experiments both for transmitting and receiving. For transmitting, a method of application was devised which led to slightly improved results, but

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for receiving, the rough trial made indicated that they were ineffective.

(*To be continued.*)

DETERMINATION OF THE DISTANCE AND DIRECTION OF A RADIO-TELEGRAPHIC SENDING STATION BY MEANS OF BARRETER MEASUREMENTS.

In the May number of the 'Zeitschrift für Sewachstrom technik' Monsieur Béla Gati, of Buda Pesth, contributes an interesting letter on the above subject. After referring to the highly praiseworthy action of Mr. Binns, the heroic telegraphist of the "Republic" when that ship was in peril, he continues: "It would be very much better if by means of automatic signalling on a sinking ship, the distance and direction of that ship could be determined. Suppose that the telegraphist were laid low by an accident, any sailor could quite easily signal the letter 't,' say, once a minute. This would be quite sufficient to admit of the distance and direction of the doomed ship being determined. Of course if the other ships were fitted with the so-called 'directive' antennæ this would be quite simple; but I shall take the case in which the ship receiving the signals has only the ordinary type of antenna.

"According to Duddell's rule the distance between the sending and receiving apparatus multiplied by the current produced is a constant number. Duddell proved this for great distances, but the same rule holds good for short distances (see Béla Gati, 'Physikalische Zeitschrift,' 8, s. 630). If, for example, this constant is 10,000 kilometre-ampères:

At 50 km. 200 micro-ampères will be received.
„ 47 km. 212·7 „ „ „
„ 53 km. 188·6 „ „ „

These values can be measured quite easily by mirror galvanometer on the Gati barreter system.

"If, for instance, the ship (call her the 'Baltic') coming to the rescue measures a current of 200 micro-ampères, and after sailing three kilometres from her then course she measures 200 micro-ampères again, the 'Baltic' knows at once that she is not approaching the 'Republic.' If the 'Baltic' now takes a course at right angles to the previous course, and after sailing three kilometres receives 212·7 micro-ampères, she knows that she is on the right course towards the 'Republic,' and is 47 kilometres distant from her. By always making two separate measurements on

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different courses in this way, it will be possible to determine the distance and direction of the foundering ship. It is not at all necessary to know the constant. This can always be eventually determined by repeated measurements. When the foundering ship's radiation is not constant a repetition of the measurements will be made. It goes without saying that, in this connection, it would be desirable that all wireless stations should be examined with reference to Duddell's rule. The constant gives, so to speak, the 'utility effect' of a station."

B. J. STEVENSON.

SECRET TYPE-PRINTING AND RADIO-TELEGRAPHY.

A NORWEGIAN captain named Hovland has invented a system of secret type-printing for radio-telegraphy, and lately gave a demonstration of it in Melsomvik, Norway, to the local authorities and pressmen. "Wireless" telegrams were exchanged between a station erected by the inventor and a station at Tjömö, belonging to the Norwegian Navy, over a distance of twenty kilometres. By the experiments Hovland showed how it was possible by means of his system to ensure absolute secrecy of communication and how easily ordinary type could be automatically converted into secret characters. The characters are transmitted by means of a key-board similar to that used on an ordinary type-writing machine. On reaching the receiving station the telegram may be received at will in secret or ordinary type. Hovland is a Norwegian naval officer, and has had considerable aid in perfecting his invention from the naval authorities of Norway, at whose disposition he has placed the results of his labours.

B. J. S.

MULTIPLEX WIRELESS TELEGRAPHY.

AN invention, which has just been patented in Berlin by F. van der Wonde, has for its object the adaptation of wireless telegraphy to multiplex working. The antenna is joined to a spiral device carrying a number of contact arms, which, when revolved, makes the following connections: (1) Transmitter joined up; (2) antenna earthed; (3) transmitter cut out; (4) receiver joined up; (5) earth disconnected; (6) receiver cut out. The speed of action is such that several revolutions take place during the time necessary for the sending of a Morse dot.

B. J. S.

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THE MACHINERY OF THE POST OFFICE.

By H. A. Miles.

(*Continued from p.* 138.)

In March, 1907, it was decided to equip the sorting office at Birmingham Head Post Office with conveyors; three were proposed, but of these only two have been installed. The first runs from the posting boxes in Victoria Square, passing through a short subway underneath the public office, then rising into the sorting office, a total distance of 65 ft. Previously a small tramway had been used to bring the baskets into the office; these baskets were filled from the posting-box openings in the usual way, and boys employed to push them along the track and to substitute empty baskets in their place. The tramway was demolished and an endless belt conveyor substituted; special shoots have been fitted to the street posting boxes, which were altered to give one opening 4 ft. 6 in. long, and also to a box on the public office counter. By these means the correspondence is deposited straight on to the belt, and brought in a continuous stream to the delivery table in the sorting office. The belt, which is cotton, rubber covered, 18 in. wide, 140 ft. in length, and having a speed of 185 ft. per minute, runs in a sheet steel trough, supported upon a light angle-iron frame fixed to the subway floor; the purpose of this trough is to prevent the possibility of postcards being held up during transit. The belt, as in the case of the Mount Pleasant conveyor, dips suddenly, and rises through the opening originally provided for the tramway into the sorting office, and to a delivery table placed at the same height as the sorting tables. The correspondence is distributed from this point by hand. The motor, of 2 brake-horse-power with worm and tension gear, is on the subway floor underneath the belt, so that a clear gangway is left along the whole length of the subway.

The main conveyor is used to collect newspapers and packets from the bag-opening tables and bring them to the stamping table. These tables are all in line, and extend a total distance of 180 ft. The conveyor itself runs under the floor of the office, and consists of a light steel lattice framework, 2 ft. 2 in. wide and 2 ft. 5 in. deep, suspended from the floor beams, mainly by girder clips, but firmly anchored at both ends. The belt is of cotton, rubber covered, 13 in. wide and 320 ft. long, running at a speed of 185 ft. per minute, and arranged to give a clear height of 1 ft. 9 in. to the top of the conveyor frame. Belts of this class, though heavier and less flexible than the cotton, have a longer life. Shoots are fitted to each sorting

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table, running through a hole in the floor, and making an angle of 40° with it, finally terminating on the top member of the lattice frame. One shoot is provided for each pair of sorters, and there are thirteen shoots in all. They are arranged to stop at the top of the framework, in order that there may be sufficient height above the belt, for packets from the more remote shoots and from those nearer the delivery end, to be carried along at the same time.

The packets and newspapers are fed into the shoots through holes in the table tops, which are so protected that other letters cannot fall into them.

The motor, of 3 brake-horse-power, with the worm gear driving the conveyor, and completely enclosed by wire guards, is placed in the basement at the end of the belt furthest from its delivery point.

After passing the last shoot the belt dips suddenly, and then rises through the floor at an angle of 15° to the middle of the stamping table, where, at a height of about 1 ft. 6 in., it discharges the packets.

The tension gear is placed under the frame, at the point where the belt dips before rising, and is of the adjustable screw type.

The whole of the conveyor is enclosed by wire-mesh guards, provided with doors where access to bearings is required. It is thus quite impossible for any person to tamper with the correspondence on its way to the stamping table.

It was frequently found that small postal tubes, after sliding down the shoot at the point of dip, refused to rise on the belt, and remained at the bottom turning round and round. The difficulty was overcome by placing a small projection at the bottom of the shoot, just sufficient to turn the tubes at an angle to the vertical plane, when they would immediately rise. The Postmaster reports that both of these conveyors are rendering excellent service.

During 1908 a comprehensive scheme of improvements for the Mount Pleasant Sorting Office was considered, and it is proposed to instal very shortly no less than seven conveyors.

One of these, for the letter-sorting office, is shown by **6**, **7**, and **8**, and a typical section through the conveyor frame is given by **8A**. The purpose of this conveyor is to take faced letters from the general sorting division on the ground floor to the Great Eastern and South-Western divisions on the floor above. The letters will be placed in baskets, 19 in. by 11 in. by 6½ in. deep, carrying a maximum of 800 letters, and having a gross weight of 21 lb. The conveyor is divided into two portions, as shown in **6**, which are connected by a steel shoot (1). The braced steel framework of the collecting belt is, as will be seen from **8**, anchored to the main girders of the building, and so arranged that, immediately after leaving the side of the lift, there is sufficient height below to leave the gangway in front of the

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lift opening quite clear, as this is one of the most important thoroughfares in the office.

The delivery belt shown by **7** is carried by a similar frame hung from the ceiling beams. The arrangement of the rollers at the point of dip (2) and the belt rising to the delivery table (3) is clearly shown. The delivery table in this case will be hinged so that it may be dropped when not in use, to increase the gangway space. Each belt is 14 in. wide, and has fixed upon it special battens of sufficient pitch to allow the baskets to lie between them, for the reason that the angles of elevation adopted for the rising portions were too great to allow the use of a plain belt. As great inconvenience would be caused to the sorting staff by adjustment of the conveyor during working hours, and the belts, especially if of cotton, alter in length considerably with atmospheric changes, tension gears of the automatic type will be used; these are indicated for the collecting belt at 4, for the delivery belt at 5.

It being quite impossible to give up gangway space on the ground floor, a specially shaped gravity feeding-table (6) will be used; baskets placed on this table will slide on to the moving belt. A scale is given on the drawing which will show the general dimensions. The Colonial Division in the Parcel Office, will also be equipped with a conveyor for raising parcels from the general sorting and dividing table on the ground floor, to the first floor. The general arrangement of the frame—which has a width of 3 ft. 3 in., a height of 3 ft. 9 in., and rises at an angle of 35°, together with the method of fixing—is similar to that shown for the collecting belt in **8**. While the driving and tension gears are practically the same as those for the delivery belt in **7**, the motor will be of 3 brake-horse-power. The conveyor will be 40 ft. long, with a main belt 25 in. wide, 100 ft. long, to run at a speed of 180 ft. per minute, which will be fitted with battens 4 in. deep and having a pitch of 3 ft. 9 in.

The parcels themselves will not exceed 11 lb. in weight or 2 ft. in width.

The main conveyor is fed by a short plain belt running by the end of the dividing table on the ground floor, and at about the same level, so that no additional exertion is necessary on the part of the staff when loading the conveyor. The parcels are discharged by the main belt on to a second dividing table, where they will be sorted as they arrive.

It is also proposed to move the Irish Division from the ground to the first floor, and to provide an elevator to take correspondence to that Division from the General Division. The finger-tray type will be used; it will be required to deal with baskets 2 ft. square by 2 ft. deep. The moving portion of a tray elevator consists of two vertical

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MOUNT PLEASANT SORTING OFFICE.
CONVEYOR FOR FACED LETTERS.

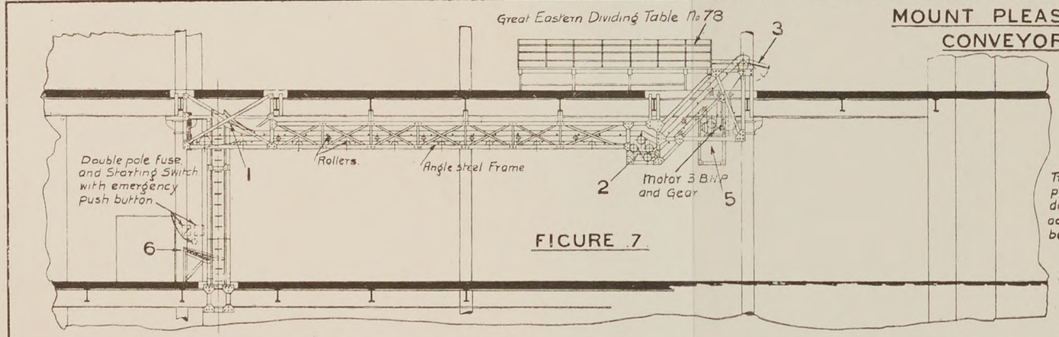
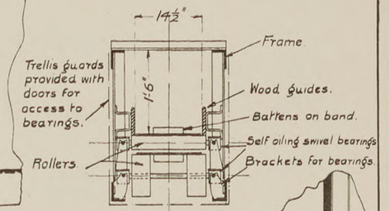
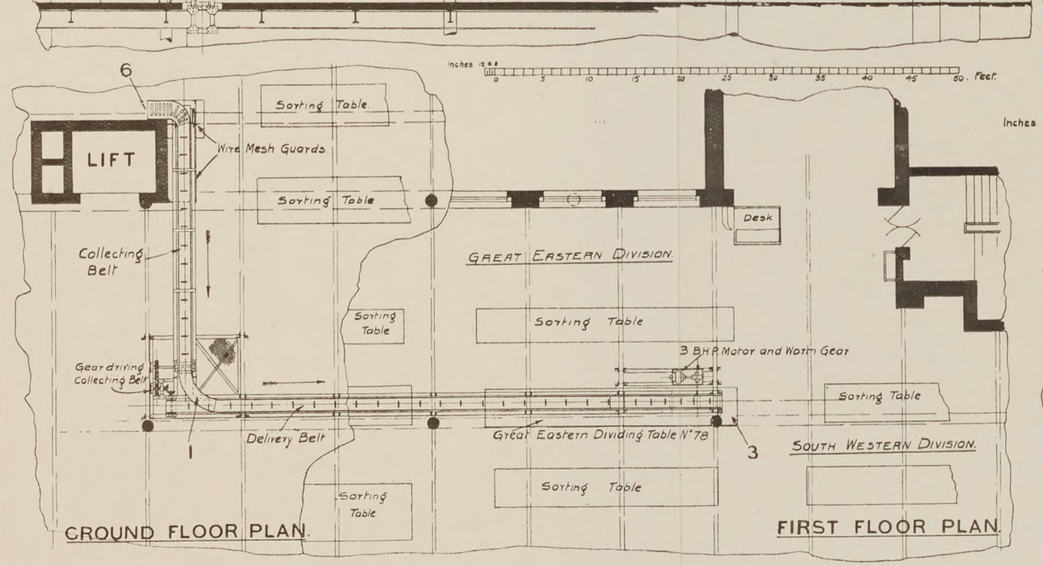


FIGURE .7



GENERAL SECTION.
FIGURE 8A.



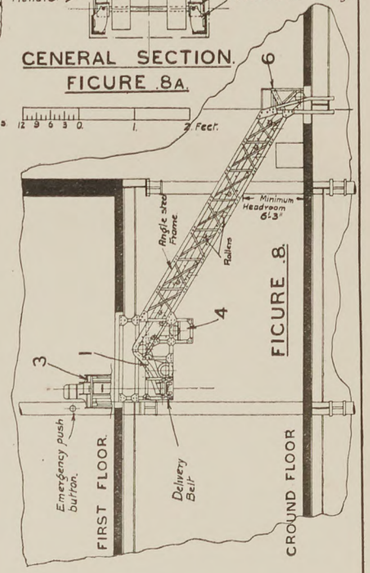


FIGURE .8.

FIGURE .6.

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chains, between which are slung a number of trays formed with fingers like that of a human hand, the chains revolve on wheels placed at the top and bottom of the elevator, and the moving trays are swivelled so that they remain horizontal while passing between and round these wheels. Fixed fingers are provided upon which the baskets may be loaded, either direct or by a gravity feeding table, and the moving trays, passing slowly up between the openings of these fingers at a speed varying from 60 ft. per minute to any convenient figure, pick up the baskets, carry them up to and round the upper chain-wheels, descending on the other side until they come into contact with the delivery fingers; the trays then pass down between the openings of the fingers leaving the baskets upon them, and the fingers being inclined the baskets slide down on to the receiving table.

If this explanation is not given quite clearly, the action of the elevator will be understood if a closed foot-rule is placed upon the outspread fingers of the right hand, and the fingers of the left hand passed up between those of the right; the rule will then be raised by the left hand. A second set of fixed fingers will be provided for use in bringing down the empty baskets, the first set being thrown out of gear during this operation. The elevator will be driven by a motor and worm gear through the upper chain-wheels.

The remaining four conveyors are to be placed in the parcel sorting office, and used for distributing parcels from the general dividing tables to four of the largest Divisions, viz. Euston, King's Cross, Waterloo and London Bridge and Town. The conveyors will be fixed entirely in the basement, and will run side by side under the dividing tables for a distance of 140 ft. Each belt will be 25 in. in width, the total length of the four conveyors being 750 ft.; over 1700 ft. will be used. At each division the conveyor serving it will be brought through the floor in a manner similar to that indicated in **7**, and on to a sorting table. There are four general dividing tables, and a pair of shoots to each of the four belts from every table will be necessary. In addition to this a second series of shoots will have to be provided, as the whole of the dividing tables are moved to another position during the busy Christmas season. This complication presents a problem of unusual difficulty, as the sixty-four shoots required have all to be arranged in a comparatively small space, and the conveyor frames kept sufficiently close to the basement ceiling so as not to obstruct the gangways on that floor.

At the close of 1908 it was proposed to provide a conveyor at the Glasgow Head Post Office for packets and newspapers, running from the bag-opening tables to the stamping tables. It was not possible to fix this conveyor beneath the floor, the engine and boiler rooms being under the sorting office, and it has been decided to carry the

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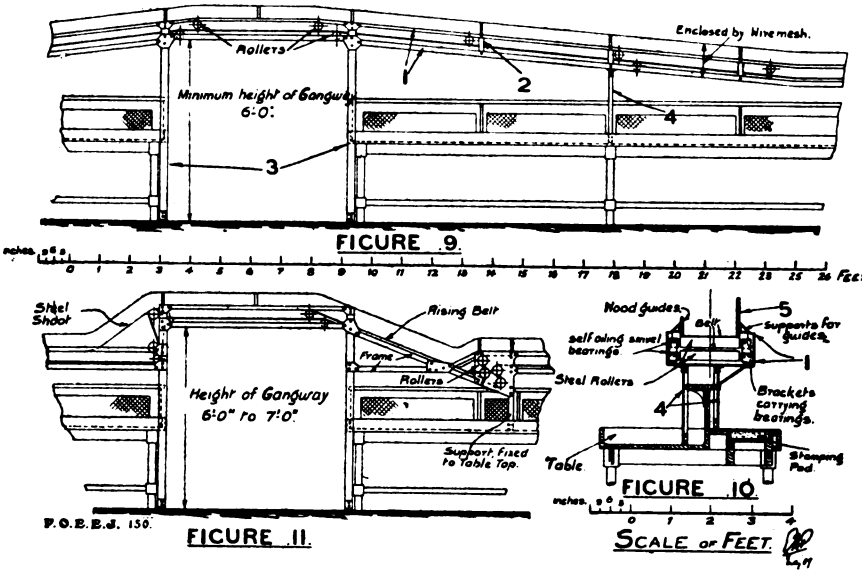
frame over the sorting tables. It was necessary, as in the case of Manchester, that sorters should be able to place packets on to the belt, and also that the gangways between the four opening tables should be left clear. The conveyor is divided into two parts, the collecting portion, 160 ft. in length, running over the tables, and the delivery portion, 55 ft. in length, which runs at right angles to the first, and the frame for which is bracketed from the end wall of the sorting office. Both the belts are 16 in. wide, and will run at a speed of 180 ft. per minute, the collecting belt having a length of 380 ft., and the delivery belt of 100 ft. The 5 brake-horse-power motor and gear will be placed below the floor, under the extreme end of the first opening table. The belt, after leaving the driving pulley, will be



brought up vertically and along the top of the tables at such a height as to leave a clearance of 6 in. between the bottom of the frame and the shelf. 9 shows an elevation of the conveyor, and the gradual rise from the centre of the table to a height sufficient to cross the gangway.

10 gives a section of the conveyor in the middle of the table; the frame is placed more to the stamping side to facilitate the emptying of the bags on to the table. The frame will be composed of angle-steel (1) with vertical angle stiffeners (2), and carried mainly by braced frames (3) fixed to the floor at each gangway; light supports (4) will be fixed to the tables to stiffen the frame. The various portions of the mechanism are indicated in 10, in which it will be noticed that the back guide (5) is carried up to prevent packets when

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thrown on the belt from falling on to the men engaged in stamping. At the end of the last opening table the collecting belt discharges its contents down a curved steel shoot on to the delivery belt, which rises at an angle of 17° to a height of 11 ft. above the floor; the packets are delivered from the conveyor down a long, specially curved shoot on to the facing and stamping table, which is parallel to the opening tables. The delivery belt is driven by the collecting belt through bevel and chain gearing, placed under the connecting shoot, and its tension gear, which, for reasons of space economy, is of the adjustable screw type, is fixed at the point where the belt joins the delivery shoot.

Tension gear of the same type is provided for the collecting belt, and fixed under the end of the last opening table. The starting gear is fixed on the wall of the sorting office at the motor end, and three emergency push buttons, as previously described, will be provided. In addition to the improvement in the routine work it is estimated that the capital cost of the conveyor will be saved in a little under six years. One disadvantage of this switchback type of conveyor is, that as the angle of rise must be very slight, depending upon the weight of the band, it is nearly impossible for the sorters using the last bay at each end of the opening tables, to throw the packets on to the belt without undue fatigue. A method of overcoming this difficulty is shown by 11, from which it will be seen that the last bay at each end of the table, can be used with as much comfort as those in the middle. The arrangement is simply an adaptation of the dipping and raising of the belt previously mentioned.

It will not be possible to describe the scheme proposed for the King Edward's Building in detail, as the final designs have not yet been prepared, but an outline of the arrangements will be given.

The complete installation will consist of ten conveyors, with one exception of the endless belt type. Six of these will run on the ceiling of the sub-ground floor, from the posting boxes in King Edward Street to various parts of the building. One will run over the tables on the ground floor, and two over the tables on the first floor. The tenth is an elevator, which will work between the ground and the first floors.

Dealing with these in order, we have first, the conveyor taking the foreign correspondence from the posting boxes to one of the platform lifts. It has a total length of 95 ft. The belt will be 18 in. in width, and have a speed of at least 180 ft. per minute. The correspondence, as it falls from the posting boxes, is placed into baskets, which are loaded on to the conveyor. On arrival at the delivery end the baskets will slide down a suitably inclined shoot on to a table opposite the lift, to be taken by it to the Foreign Sorting

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Section on the first floor. An almost identical conveyor, running in the opposite direction, will be provided for carrying the empty baskets from the lift to the posting boxes. Two 5 brake-horse-power motors placed on the sub-ground floor, and in the posting enclosure will be provided to drive these conveyors.

The Inland and Transfer bag conveyors, running from the posting boxes which are at the east end, the whole length of the building, and rising on to the platform at the extreme west end, have a total length of 450 ft. each. Such is the importance of this service that two identical but entirely independent conveyors will be installed, so that in the the event of the breakdown of one of them the other will be available for use. **12** shows a typical bay of one of the proposed frames at a point where it is passing directly beneath the sorting

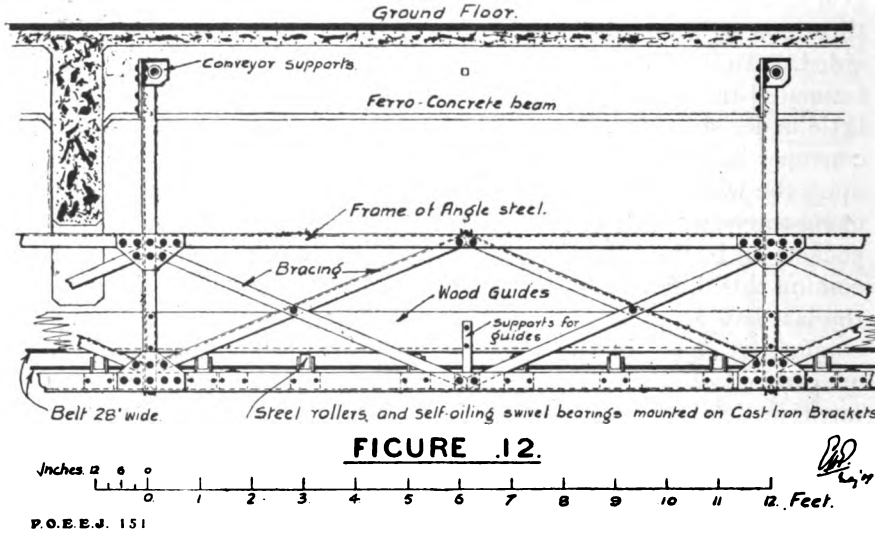
Ground Floor.
Conveyor Supports
Ferro-Concrete beam
Frame of Angle steel.
Bracing
Wood Guides
Supports for Guides
Belt 28" wide.
Steel rollers and self-oiling swivel bearings mounted on Cast Iron Brackets
Inches 12 6 0
0 1 2 3 4 5 6 7 8 9 10 11 12 Feet.
P.O.E.E.J. 151

FIGURE .12.

office floor. The whole of the framework, with the exception of the two ends, will be hung from supports fixed between the ferro-concrete beams. A scale is given so that the dimensions of the various portions can be read. Each belt will be 28 in. in width, 1000 ft. in length, and will run at a speed of 180 ft. per minute. Two 20 brake-horse-power motors, with worm gear, will be provided for driving the conveyors; these will be fixed on the sub-ground floor within the posting enclosure. The necessary switch gear for these and the other four posting-box conveyors will be placed in a convenient position in the posting enclosure. Both conveyors will discharge on to a special platform built out from the ordinary loading platform, and at this point the tension gears will be located, necessarily of considerable dimensions for belts of such great length. The correspondence, as it comes from the boxes, will

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be placed in bags in the enclosure and laid on a short belt rising from the floor, which, for the convenience of the staff, will be used to feed the main belts. At a distance of 100 ft. from the posting boxes, a shoot from the east loading platform is provided, and will be used for bags brought in by the mail vans from district offices, and which require to be transferred to the west platform.

The London conveyor will deal with the town mails from the posting boxes, and will be almost identical in design with that for the foreign correspondence, except that it will be 140 ft. in length and discharge the baskets on to a sorting table on the ground floor; the arrangement of this delivery end will be very similar to that shown in **7**. A return belt for carrying the empty baskets back to the posting boxes will be provided, and fed through a steel shoot placed under the sorting table on which the main belt discharges. Two 6 brake-horse-power motors will be placed in the posting enclosure to drive these conveyors. The three overhead conveyors will be designed on the same lines as that described for the Glasgow Head Post Office, the one on the ground floor running from the bag-opening tables to the District and Sub-District Divisions, those on the first floor distributing from the Foreign Division to the Continental and Colonial Divisions respectively. Each of the three conveyors will probably exceed 150 ft. in length. The elevator is of the finger-tray type previously described as part of the Mount Pleasant scheme, but smaller, as it will only have to deal with baskets of the same size as those used with the posting-box conveyers. The elevator will be used for carrying the General letters from the ground floor to the Foreign Section on the floor above, and returning the empty baskets to the ground floor. A motor and gear of 4 brake-horse-power will drive the elevator.

The total power represented by the motors of the complete installation is 80 brake-horse-power. The estimated net weight of the two Inland and Transfer bag conveyors is 65 tons, and the total net weight of the six posting-box conveyors is approximately 90 tons. Assuming a maximum weight of 80 lb. for a full bag and 27 lb. each for the baskets, the approximate gross weight of the six conveyors when all are at work will be 94 tons—certainly no inconsiderable weight.

There is probably no post office in the world that can boast such an installation of mechanical appliances as will be possessed by the "King Edward's Building" when completed, and the interest taken in its progress will justify a detailed account of its equipment being given in a future issue.

Thanks are due to Mr. W. Howson, Chief Superintendent of the Mount Pleasant Sorting Office for permission to take the photographs reproduced in **4** and **5**.

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MODERN ILLUMINATION.

By E. G. KENNARD,
Testing Branch, G.P.O.

IN the following paper it is proposed to indicate the status of the art of illumination at the present day. Owing to the extent of the subject, however, and to the relatively small space available in these pages, it will of necessity deal only with methods widely adopted, and also be limited to conclusions of a general nature.

Apart from actual methods of producing artificial light, the subject of illumination has recently been given much more attention than was formerly the case, partly resulting from modern requirements and conditions, and also from the continual observation of

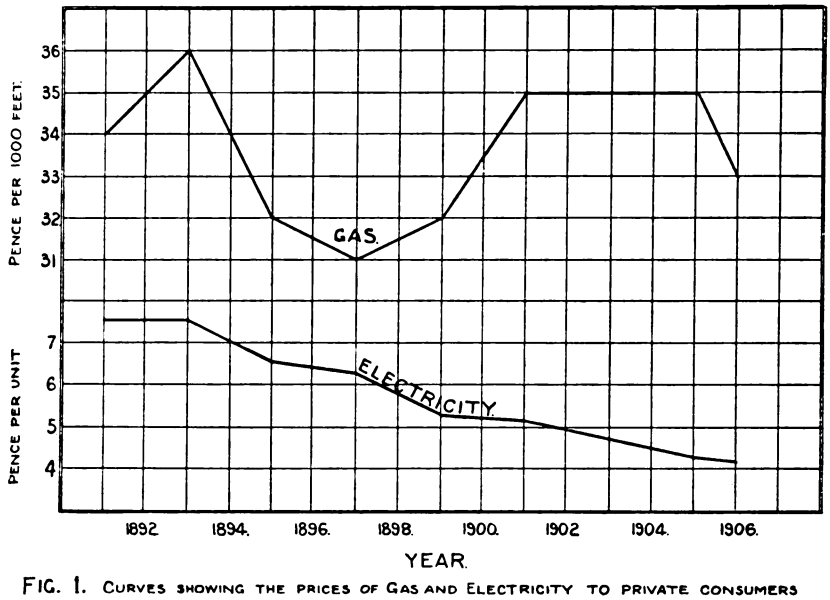

FIG. 1. CURVES SHOWING THE PRICES OF GAS AND ELECTRICITY TO PRIVATE CONSUMERS IN LONDON DURING THE PAST 16 YEARS.

many installations where the illumination leaves much to be desired. It is proposed to draw attention in this paper to the essential features to be observed when planning the lighting arrangements of a building.

The possibilities of successful illumination are in some measure dependent upon the source of artificial light available. Although there are many different methods in existence for producing light, yet gas and electricity are the only two methods which are in universal use, therefore attention will be confined to these two sources.

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Since the introduction of electricity for lighting purposes on a commercial scale, some twenty years ago, there has been keen competition between it and gas for the premier position as an illuminant. In 1 some curves are plotted which show the variation in the selling prices of gas and electricity to the private consumer in London since the year 1891.

These curves were plotted from data contained in the 'Gas Engineer's Text-book' and 'The Electrical Directory,' and represent the average price of all the supply companies. From 1 it is noted that the price of electricity has fallen during the past eighteen years to nearly one half of its former value, while during the same period gas has undergone fluctuations in price, the rise commencing at the year 1899 probably being due to the introduction of the incandescent mantle. A similar rise in the price of current has also been predicted owing to the extended use of the metallic filament lamp, although as yet prices have undergone but little change.

Great improvements have been effected during recent years in the methods of lighting, resulting in increased efficiency, improved colour, steadiness of pressure, and reliability. The following table gives the pioneer lamps and their specific energy consumption for each system, and below these arranged in order of merit are the more recent types of improved efficiency.

Gas Lighting.

Type of burner.	Cubic feet per hour per candle.
Batswing burner	·38
Argand burner	·31
Welsbach mantle	·08
Inverted mantle	·075
High-pressure mantle	·045

Electric Lighting.

Type of lamp.	Watts per candle.
Carbon glow lamp	3·75
Nernst lamp	1·5
Metallic filament lamp	1·25
Mercury vapour lamp	0·5
Quartz vapour lamp	0·27
Flame arc lamp	0·20

These figures indicate the remarkable advances which have been made in the efficiency of light production, although, without further data, one would be unable to obtain their relative values for economical comparisons. This will be readily recognised when the individual characteristics of each lamp are studied, taking into account the candle-power emitted, the initial cost of the lamp, and the expenditure on renewals. Moreover the selection of the

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system to be used, and also the type of lamp, cannot be made until certain particulars regarding availability of supply and quality of the illumination desired are known.

The following requirements are essential when it is desired to provide artificial illumination having a high standard of excellence.

(1) Complete shading of any brilliant source of light from the vision.

(2) Uniform distribution of light at an intensity of 0·75–2·0 foot candles according to conditions, with arrangements for producing special lights where necessary.

(3) Colour to be as near as possible to that of daylight.

(4) The above conditions to be carried out at a minimum cost.

One of the most serious errors occasioned in present-day lighting is the widely extended use of unshaded lights of high intrinsic brilliancy, the effect of which is to cause pupillary contraction of the eye, and consequently reduce visibility. The researches of M. F. Laporte show that where unshaded lights of high intrinsic brilliancy are used a much higher standard of illumination is required, this being much more noticeable where the illumination is below 1 candle foot. The following table shows the intrinsic brilliancy of various illuminants, the values being given in candle-power per square inch of light-emitting surface—

Source.	Candle-power per square inch.
Sun	635,000
Electric arc crater	100,000
Carbon glow lamp	250
Incandescent mantle	50
Mercury vapour lamp	19
Moore vacuum tube	1·0

The only source of light which could be regarded as having a sufficiently low value of candle-power per square inch is the Moore vacuum tube, the value 1·0 usually being allowed as a safe working value.

However, the peculiar properties of this lamp render its use inadmissible for many classes of lighting work.

Some tests on the intrinsic brilliancy of daylight were recently carried out by Dr. Basquin at Chicago, with the following interesting results:

Condition of sky.	Candles per square inch.
Clouds with no blue	1·4
Cloudless clear blue	2·1
Blue predominating	3·1
Clouds predominating	3·9
Overcast, no blue	4·3

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From the above results an average value of 2·96 candles per square inch might be taken as representative of the intrinsic brilliancy of the sky in the zenith at approximately 12 o'clock noon.

For purposes of artificial illumination, however, the value 1·0 should not be exceeded, and where possible a still lower value should be employed.

In order to reduce the intrinsic brilliancy to a value of one candle per square inch, or less, it is necessary to adopt one of the following means:

(1) Increase the area of the light source.

(2) Employ suitable shades or screens.

(3) Entirely shield the actual source of light, and distribute same by means of reflection.

The first method would be impracticable owing to its inefficiency.

The second method is one in general use, but unless the globes or shades are carefully selected the system is likely to be highly inefficient.

The most efficient manner to obtain diffusion by means of globes is to employ those made of prismatic glass such as the holophane patterns, care being taken to obtain the correct diameter.

The formula given below is of use for determining the approximate diameter of a globe required to reduce the surface candle-power to a value of 0·25 per square inch:

$$D = \sqrt{\frac{MSCP \times K}{0{\cdot}25 \times 3{\cdot}14}}$$

Where D = diameter of globe in inches.

$MSCP$ = mean spherical candle-power.

K = a factor varying according to type of globe employed.

Values of K for Various Globes.

Clear glass	·9
Prismatic glass	·85
Smoked glass	·80
Frosted glass	·70
Opalescent glass	·65
Opal glass	·5

Thus in a case where it is proposed to employ 100 candle-power lamps contained in prismatic globes, the correct diameter would be—

$$\sqrt{\frac{100 \times {\cdot}85}{0{\cdot}25 \times 3{\cdot}14}} = 10{\cdot}8 \text{ inches.}$$

The importance of keeping all shades and globes thoroughly clean and free from dust cannot be too distinctly emphasised, and with a view to justifying the statement made above, some results are given below in tabular form of a series of tests carried out to deter-

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mine the amount of light absorbed by allowing dirt and dust to accumulate on the globe of an electric lamp in service in an ordinary business office.

Tests on a 1 ampère Nernst lamp with 6-inch opalescent globe, to determine the amount of light absorbed by deposited dirt during a period of three months.

	Angle of incidence.	0	45°	90°
Clean globe at start	Candle-power of test lamp	51	50	44
	C.p. through globe	35·6	33	28
	Percentage of light passing through (= K in above formula)	70	66	63
	Average value of K	—	66·3%	—
After six weeks	Candle-power of test lamp	52	50·5	45
	C.p. through globe + dirt	31·2	29·4	26
	Percentage c.p. through globe + dirt	60	58	58
	Percentage of light absorbed by dirt	10	8	5
	Average value of ditto	—	7·7%	—
After twelve weeks	Candle-power of test lamp	47	49	46
	C.p. through globe + dirt	25	26·5	25
	Percentage c.p. through globe + dirt	51	54	54
	Percentage of light absorbed by dirt	19	12	9
	Average value of ditto	—	13·3%	—

The measurements were taken in three directions—directly beneath the globe, at 45 degrees to the vertical, and also in the horizontal plane, the most dirt collecting on the lower sides of the globe, as may be inferred from the table. The results of this experiment show that after six weeks had elapsed the dirt obstructed 7·7 per cent. of the light, this value being increased to 13·3 per cent. after a period of twelve weeks, and in the light of these figures further argument on behalf of cleaning globes is needless.

The most excellent system of illumination, viewed from all points except that of lowest economy, is undoubtedly the system known as indirect lighting, where the actual light source is not visible, but the rays from which are thrown by means of an inverted shade upon a suitable reflecting surface above, the result being an evenly diffused light, perfectly free from glare, and also an entire absence of sharply defined shadows. This method of illumination is illustrated by some tests shown in **2**, the particulars of which are here appended.

Dimensions of room, 14 ft. long, 14 ft. wide, 10 ft. 6 in. high, containing 196 square feet.

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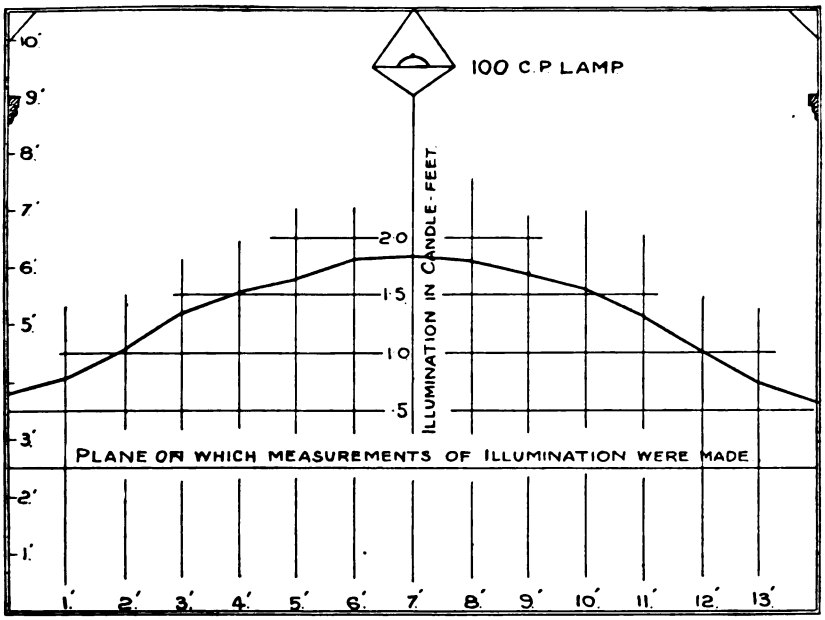

FIG. 2. MEASUREMENT OF ILLUMINATION IN A ROOM 14FT SQUARE, THE LIGHT BEING REFLECTED BY A WHITE CEILING FROM A 100 CANDLE POWER INVERTED FITTING.

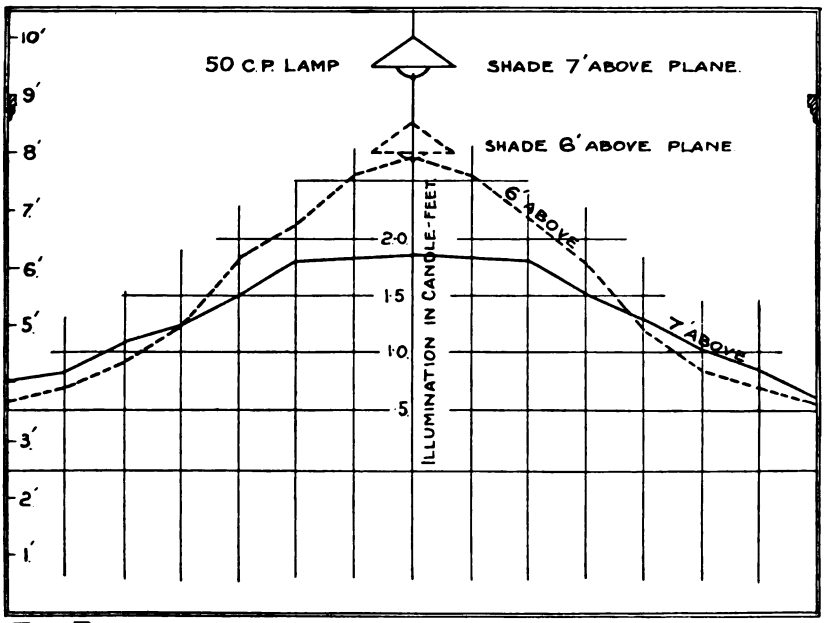

FIG. 3. MEASUREMENT OF ILLUMINATION IN A ROOM 14' SQUARE, BY MEANS OF DIRECT LIGHT FROM A 50 C.P. LAMP.

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Decoration scheme.—Ceiling, white; frieze, light cream tint; walls below picture rail, a light green.

Source of light.—One 100 c.p. Osram lamp, contained in an inverted bowl-shaped reflector 15 in. below the ceiling, arranged in the diagonal centre of the room.

Illumination measurements.—These were made with a portable photometer in a horizontal plane corresponding to the height of a table above the floor, and a value of not less than 0·75 candle feet was obtained at a horizontal distance of 1 ft. from the walls of the room. As shown in **3** a similar set of readings were taken, substituting a 50 candle-power direct light for the inverted fitting, other conditions remaining unchanged.

In order to show the importance of having the lamp adjusted to the correct height, two sets of readings were taken, at 6 ft. and 7 ft. above the table plane respectively. At the 6 ft. position the lamp is obviously too low, resulting in insufficient light at the sides of the room, and an unnecessarily high value at the centre. It will be interesting to compare the results of tests in **2** and **3** in tabular form, and also to show the approximate energy consumption of each method.

	Direct.	Indirect.
Candle-power of lamp . . .	50	100
Surface in square feet illuminated above 0·75 candle feet . . .	160	144
Watts, using Osram lamps . .	65	130
Cubic feet of gas per hour, using mantles	4·0	8·0
Watts per square foot . . .	·41	·9
Cubic feet of gas per square foot .	·025	·056

From these results the indirect system is seen to incur about double the cost for energy that is required for direct lighting, although the illumination was far superior to the former system, the complete absence of visual strain and the excellent diffusion of the light being specially noted.

In order to obtain successful results with the indirect system of lighting careful attention should be given to the following points:

Inverted reflectors should preferably be of silvered glass in order to have high reflective efficiency, they should be designed to throw as much light to the outer edges of the ceiling as possible, and they should be fluted in shape so as to break up the rays of light and so obtain improved diffusion. The ceiling, or overhead diffuser, should be maintained perfectly white; unless this be done the quality of the light will deteriorate. The successful operation of this scheme almost entirely depends on the efficiency of the reflectors employed. In view of the latter statement it is advisable to employ a source of light which will not occasion blackening of the walls and ceiling.

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The illumination should in no part have a value less than 0·75 candle feet.

Where possible the general colour scheme of the walls and fixtures should be chosen so as to absorb as little light as possible.

It is also desirable not to employ values exceeding 3 or 4 candle feet, the human eye being very sensitive to changes in illuminating values up to 3 or 4 candle feet, but above this value practically all discriminating power is lost. The following figures, due to L. J. Lewinson, are interesting in this respect:

Sky illumination at night (no moon) . . ·001 ft. candles.
Sky illumination at night (full moon) . . ·02 ft. candles.
Average daylight illumination . . 2000–8000 ft. candles.

For instance, one would readily appreciate any change ranging from moonlight to an average value of indoor illumination, being an increase of fifty fold.

But the difference from 1·0 to 8000 candle feet would not be appreciated to any such extent as the increase from ·02 to 1·0 candle feet, hence the futility of providing excessive values for artificial illumination.

The accurate estimation of lighting costs is a somewhat tedious undertaking, there being several variable quantities involved, of which the following are the most important:

(1) Initial cost of installing system.
(2) Costs for renewals of lamps, mantles, carbons, globes, etc.
(3) Charges for energy.
(4) Charges for cleaning, trimming, etc.

Lighting costs are usually expressed in pence per candle hour, but as this is an inconveniently small unit, costs will be considered in this paper in terms of the kilo-candle hour = 1000 candle hours. Items 1, 2 and 4 may be regarded as fixed charges, and expressed as such in terms of pence per kilo-candle hour. Item 3 is a variable charge which depends on the efficiency of the lamp to be employed and also on the price of energy.

In making allowances for Item 1 in cost calculations the approximate life of the apparatus and fittings must be known, together with the total candle-power. Having estimated the capital expenditure the cost for capital outlay can be approximately determined in pence per K.C.H.

Where lamps of 100 candle-power or less are to be used one may, in general, consider only the renewal costs and the energy costs. In order to illustrate the method of estimating lighting costs the calculations are shown for a 50 candle-power light of gas and electricity respectively. The most efficient lamps of each system have been selected, namely the Welsbach mantle and the Osram lamp.

In 4 the percentage variation of candle-power during useful life is

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shown for a gas mantle and an Osram lamp, there being a remarkable difference between the performance of the two. The curve for the gas mantle is the average of several tests published by Dr. Bohm. Given the price of mantles at 4*d.* each and Osram lamps at 3*s.* each the following values are obtained:

	Osram.	Mantle.
Average candle-power . . .	48	45
Average useful life in hours . .	1200	230
Kilo-candle hours per lamp . .	58	10·3
Price per renewal in pence . .	36	4
Renewal cost in pence per K.C.H. .	·62	·39

The energy charges vary according to the price of gas or electricity as the case may be. The following rule is given for the calculation of energy charges:

Pence per K.C.H. = *Sp.C.* × *P.*

Gas. — *Sp. C.* = average cubic feet per hour per candle.

P. = selling price per 1000 cubic feet (in pence).

Electricity.—*Sp.C.* = average watts per candle.

P. = Selling price of current per unit (in pence).

Taking current at 4*d.* per unit, and a 50 c.p. Osram lamp consuming an average of 1·3 watts per candle during useful life, the energy cost will be as follows:

1·3 × 4 = 5·2 pence per K.C.H.

Adding the charge for renewals previously determined at ·62 pence the total lighting cost of 5·82 pence per K.C.H. is obtained. From results arrived at by the above means curves have been plotted as shown in **5**, giving the lighting costs for a 50 c.p. Osram lamp and Welsbach mantle respectively, at various prices of energy. Curves of this nature are useful for obtaining the relative costs of various illuminants when the energy charges vary between wide limits, and it is recommended that their use should be extended to include the majority of modern lamps when it is desired to form accurate comparisons of cost.

From **5** one can obtain the respective prices of gas and electricity which will supply an equal amount of light at the same cost. For instance, in a district where gas is supplied at 4*s.* 6*d.* per 1000 cubic feet, in order to be cheaper for illumination purposes electricity must be obtained at 3*d.* per unit or less. However, apart from actual working costs, there are other factors which require consideration, such as blackening of ceiling and fixtures, ventilation and ease of control, all of which have an indirect bearing on the final cost.

Where possible the relative cost in pence per square foot per hour for various systems should be obtained and the results arranged in tabular form, thus facilitating the selection of an effective and at the same time economical system of lighting.

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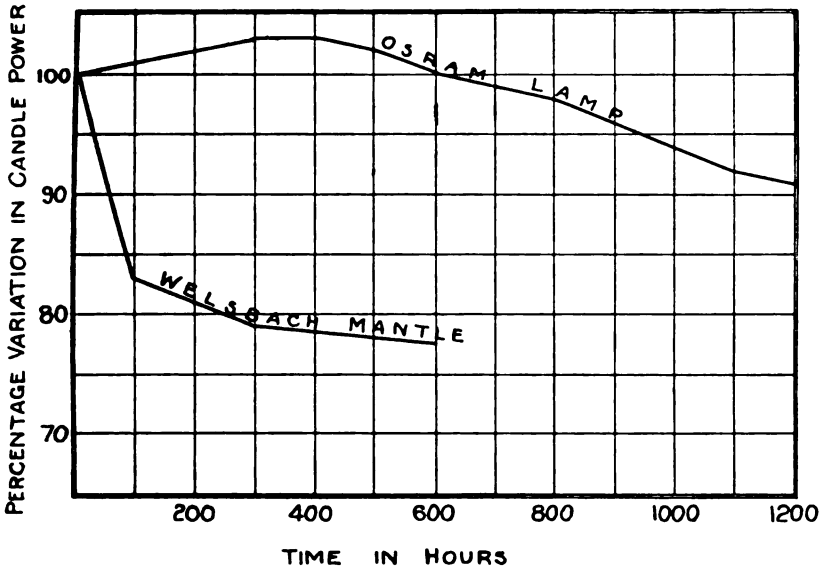

FIG. 4. VARIATION OF CANDLE POWER DURING LIFT OF AN OSRAM LAMP AND A WELSBACH MANTLE.

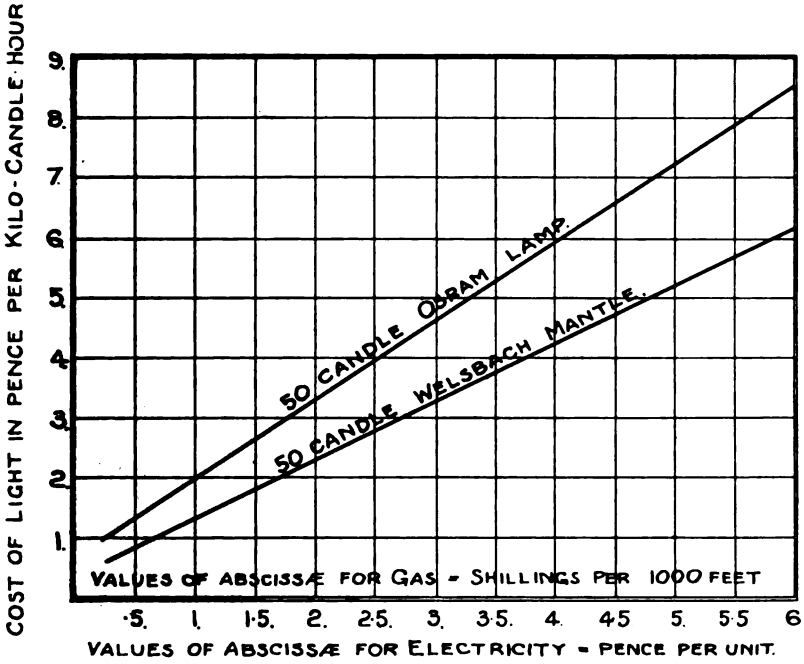

FIG. 5. CURVES FOR OBTAINING THE TOTAL COST OF LIGHT EMPLOYING 50 C.P. LAMPS OF GAS OR ELECTRICITY.

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In direct lighting it is usually preferable to instal a large number of small units rather than to have a few units of high candle-power, for by so doing the light is very much better distributed, and a greater flexibility of control is obtained. In lighting buildings of large floor area, where a high standard of illumination is required at the lowest possible cost, the indirect system is recommended, using large flame arc lamps and providing arrangements for special lighting where necessary. Where the existing conditions render the use of the indirect system inadmissible, an alternative scheme of direct lighting, using mercury vapour lamps in conjunction with suitably shaded glow lamps, to minimise the colour effect due to the lack of red rays, will give very satisfactory results.

The recent developments in vacuum tube lighting indicate great possibilities in the future for this type of lamp, its two great advantages being high efficiency and low intrinsic brilliancy, both of which are essential for successful results in illumination, and if such lamps are eventually a commercial success, many of the problems which confront the lighting engineer of to-day will be greatly simplified.

Erratum.—In Fig. 4 read "DURING LIFE."

WINTER IN THE HIMALAYAS, MINIMARG, KASHMIR. ONE OF THE HIGHEST TELEGRAPH OFFICES IN THE WORLD.

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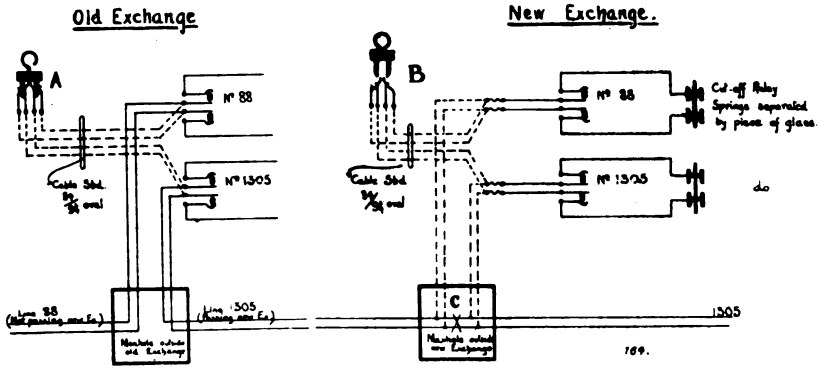
TRANSFERRING AN EXCHANGE TO A NEW BUILDING.

By J. W. TURNER, A.I.E.E.

OF late years the newspaper reader has been frequently mystified by statements that some thousands of telephone exchange subscribers had on a certain day been transferred from an old to a new exchange in so many seconds. Most of the readers of the JOURNAL are well aware of the principles on which such transfers are arranged, but it is probable that they will read with interest the following details of a standard arrangement for this purpose which has been recently designed in the office of the Engineer-in-Chief:

A "Frame, Change Over, 4000 lines," "Strips, Change Over, 100/100 pairs," and "Plugs for Strips, Change Over," will be available for this work.

Each strip accommodates five groups of 20/20 4-point switch-



springs adapted to receive insulating plugs, one plug being required for each 20/20 group.

The utility of these change-over strips may perhaps best be illustrated by taking a case likely to arise in practice.

In the diagram two subscribers' circuits, Nos. 88 and 1305, are shown as representing two different cable routes arriving at a telephone exchange which is about to be thrown out of use. The position of the new exchange is shown on the right, and it will be noticed that one of the cable routes passes the new exchange.

The ducts connecting the two manholes may be full, or the distance between the latter comparatively great, in either or both of which circumstances it may be found economical to utilise the cables between the manholes for such circuits as No. 88, which do not pass the site of the new exchange. In order that this may be

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accomplished automatically at the change over, the 4-point switch-springs of the change-over strips are wired as shown dotted at *A* and *B* by means of switchboard cable. New lead-covered cables will be laid between the frame in the new exchange and the manhole outside for leading-in purposes. The cables carrying circuits of which No. 1305 is typical will not be treated as shown at *C* until the connections between frame and change-over strips in the new exchange have been made, and separators inserted between the springs of cut-off relays to be associated with working circuits. (The new exchange, for illustration purposes, is assumed to have a common battery equipment of the Western Electric Co.'s No. 1 type or equivalent.)

The change-over strips in the old exchange will be wired in exactly the same way as in the new exchange. The springs will, however, be insulated in the old exchange by the insertion of plugs, and not so insulated in the new exchange.

The diagram gives the conditions obtaining when all is in readiness for the change over. An independent telephone circuit will of course be provided between *A* and *B*, and when the time for the change over arrives the following operations will be undertaken quickly and in the order given:

Simultaneously remove heat coils in old exchange and insert insulating plugs in new exchange.

Withdraw insulating plugs from the strips in the old exchange and request the operators at the new switchroom to proceed to momentarily insert plugs in the jacks of all working circuits, thereby actuating the cut-off relays and releasing the separators.

The separators will not be forced between the cut-off relay springs, but placed in position by gently moving the springs outwards by hand. If forced into position the necessity for burnishing a large number of contacts will arise. In order that there may be ample space for the separators to fall clear of the springs when the relays are energised, the relay covers are removed before the change over.

If the type of the test frame at the old exchange is such that the removal of the heat coils would put the circuits to earth, the earth bar will be either taken away or insulated beforehand.

An operator will be required for each working position in the new exchange, and she will be responsible for testing each subscriber's circuit for ringing, speaking, and signalling as soon as practicable after the release of the separators from the cut-off relay springs.

The insulating plugs are provided with eyelets in order that banks of five or more may be handled simultaneously.

The frame for accommodating forty change-over strips or 4000

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pairs is made up in four sections or units of 1000 pairs each. A frame unit consists of five vertical supports, each with accommodation for two change-over strips (200 pairs). Its dimensions are: height, 8 ft., width, 2 ft. 8½ in., depth, 2 ft. 4 in.; and it is designed so as to be suitable for fixing close to and parallel with a wall, being supportable from the latter by an angle-iron stay 1½ by 1½ in., provided and fixed locally.

TESTERS FOR C.B. LOCAL EXCHANGES.

By J. HEDLEY.

PAST experience in connection with the installation and maintenance of apparatus, etc., in the Department's common battery local exchanges has shown the advantage of testers of a portable size. The arrangements of the types referred to are those found to be most suitable to meet working conditions, and a brief summary of the use of each tester may be useful.

Type 4 is used for proving the operation of the relays, etc., on subscribers' line circuits, operators' cord circuits, and incoming junction circuits.

Type 5 for ascertaining the nature of exchange faults on subscribers' lines.

Type 6 for localising multiple faults due to earths or contacts.

Type 7 for proving the operation of the relays, etc., on incoming and outgoing junction circuits.

Type 8 for point-to-point testing when tracing faults.

E.-in-C's. Drawing 1805, *and Diagram C.B.* 497. *Tester Type* 4, *Line and Cord Circuits.*

This tester is made up in the form of a box, 6¾ by 4½ by 4 in., equipped with keys and lamps, etc., as shown in 1, and is used for making the following tests:

Subscribers' operators' cord circuit.—Connect peg to testing-jack and insert cord A into spare outgoing junction. Switch-spring so as to put earth on sleeve.

(*a*) If the supervisory lamp glows when the peg of the cord to be tested is inserted into switch-spring B, the sleeve circuit is free from fault.

(*b*) The continuity of the tip and ring is correct and free from reversals if the cord supervisory lamp darkens and the two lamps on the tester glow when key 5 is depressed.

(*c*) The operation of the supervisory relay is proved by operating

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keys 2, 3, and 4, keeping the 10,000ω in circuit throughout the test by means of key 4, and operating key 2 approximately three times per second; the supervisory lamp should glow and darken alternately. The supervisory relay should be adjusted so that similar results will be obtained when key 3 is operated. The action should be definite in both cases.

Cord circuit, incoming junctions.—The foregoing tests are applicable. Key 1 is also used for testing the machine ringing key through 600ω and short circuit alternately.

Subscribers' line circuit.—(*a*) When the cord on the tester is inserted into an answering jack the line-lamp should glow when keys 2 or 3 are depressed alternately, *i. e.* the line relay should operate satisfactorily through 750ω or short circuit.

(*b*) To prove the operation of the cut-off relay, key 2 or 3 should be kept depressed, and keys 6 and 7 operated singly and together, *i. e.* through resistances of 240ω, 80ω and 60ω respectively. A badly regulated cut-off relay will be revealed if the line-lamp is not extinguished under each condition.

E.-in-C's. Drawing 1778, *and Diagram C.B.* 486. *Tester Type* 5 *Line Circuit.*

This is a pocket-size tester, $3\frac{5}{8}$ by $2\frac{9}{32}$ by $\frac{7}{8}$ in., equipped with three lamps and three keys, as shown in **2**, commonly known as the three-lamp set. It is used for determining the nature of exchange faults on the subscribers' line circuits, and in some cases also the location of the fault. The operation of the tester will be clearly understood from the diagram; but there is one new feature—the insertion of the resistance in the sleeve circuit—which should perhaps be specially referred to. When testing, if two sleeves are in contact a definite result is obtained as the tip and ring lamps remain glowing when the sleeve key is depressed, due to the resistance inserted, reducing the current below the amount required to operate two cut-off relays. This is an improvement, as with testers not fitted with the resistance when the sleeve key is depressed the tip and ring lamps are extinguished, and faults due to two sleeves in contact have therefore to be determined solely by the glow on the sleeve lamp being brighter than that obtainable under normal conditions.

E.-in-C's. Drawing 1825, *Diagram C.B.* 487, *Tester Type* 6. *Drop of Potential.*

Consists of a small box, $3\frac{3}{4}$ by $1\frac{11}{16}$ by $1\frac{3}{8}$, equipped with three keys, two cords and headgear receiver 150ω, and used for locating,

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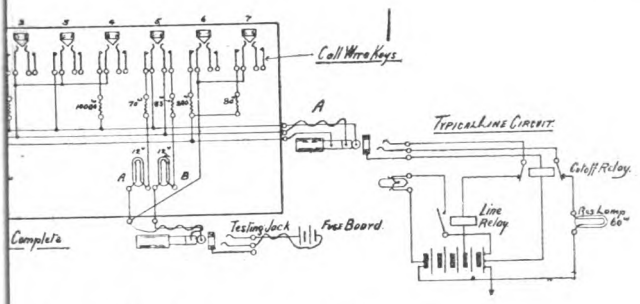
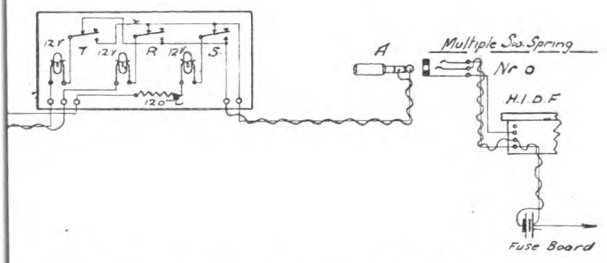
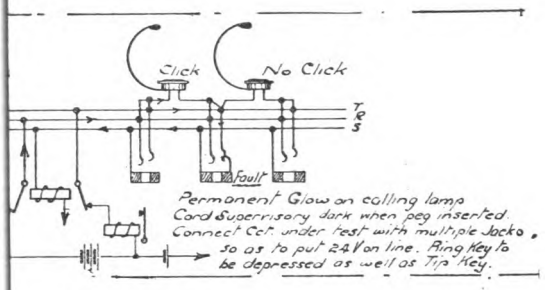


E 4, FOR LINE AND CORD CIRCUITS.

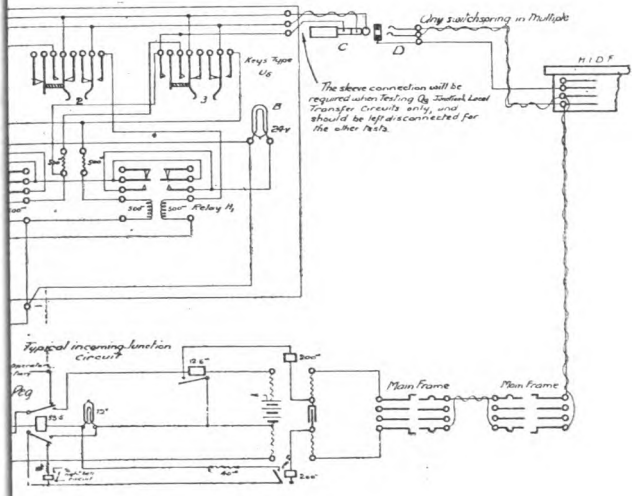


Cord A with multiple Switchspring Nr 0 to join battery to Test Set
ert Cord B in Switchspring of line under test, the lamps associated with
and Ring Keys on the Test Set should glow, and when the Sleeve Key is
d, the lamp associated should glow, and the tip and ring lamps should
quished. The accompanying Schedule gives details of the indications
Test Set for various classes of faults.

R TYPE 5, FOR LINE CIRCUITS.


Click
No Click
Tip
S
Fault
Permanent Glow on calling lamp
Cord Supervisory dark when peg inserted.
Connect Set under test with multiple Jacks
so as to put 24 V on line. Ring Key to
be depressed as well as Tip Key.

TER TYPE 6, FOR MULTIPLES.


Key switchspring in Multiple
C
D
H.I.D.F
Keys Type U6
The sleeve connection will be required when Testing Op Indirect Local Transfer Circuits only, and should be left disconnected for the other tests.
Typical incoming Junction Circuit
Peg
Main Frame
Main Frame

TYPE 7, FOR JUNCTION CIRCUITS.

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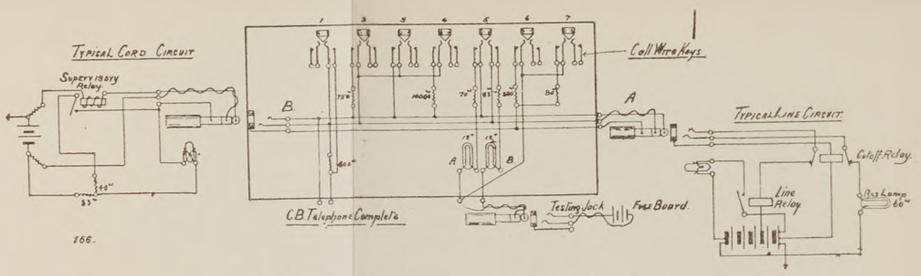
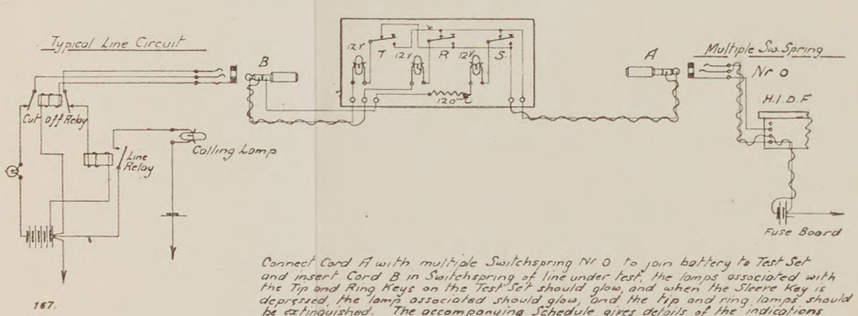
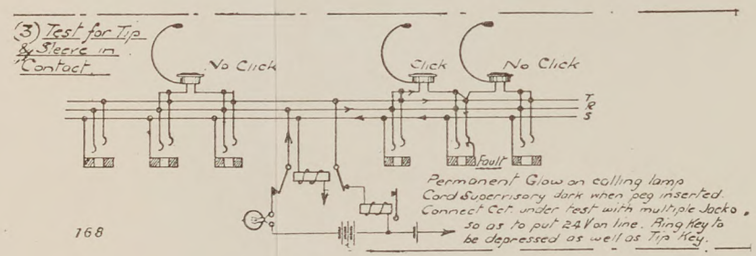


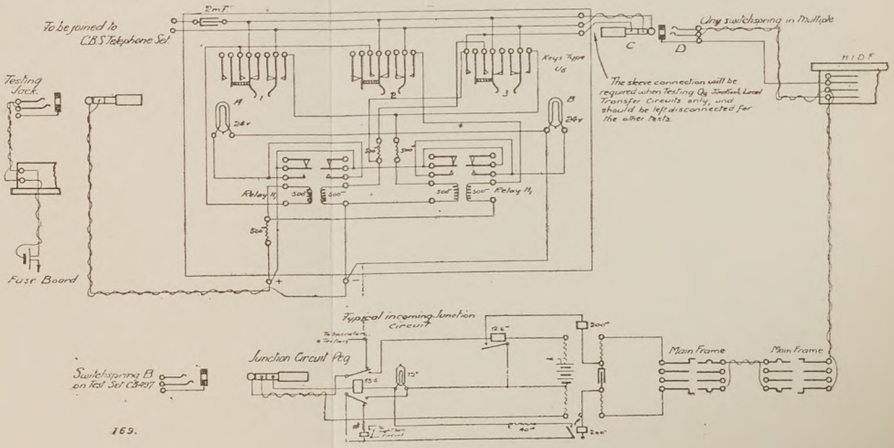
Tester Type 4, for Line and Cord Circuits.


Typical Line Circuit
Cut off Relay
Line Relay
Calling Lamp
Multiple Sw. Spring
Nr 0
H.I.D.F.
Fuse Board
167.
Connect Cord A with multiple Switchspring Nr 0 to join battery to Test Set and insert Cord B in Switchspring of line under test, the lamps associated with the Tip and Ring Keys on the Test Set should glow, and when the Sleeve Key is depressed, the lamps associated should glow, and the tip and ring lamps should be extinguished. The accompanying Schedule gives details of the indications on the Test Set for various classes of faults.

Tester Type 5, for Line Circuits.


(3) Test for Tip by Sleeve in Contact
No Click
Click
No Click
Fault
168
Permanent Glow on calling lamp Cord Supervisory lamp when peg inserted. Connect Set under test with multiple Jacks so as to put 24 V on line. Ring Key to be depressed as well as Tip Key.

Tester Type 6, for Multiples.



Tester Type 7, for Junction Circuits.

earth and contact faults in the subscribers' multiple to a particular switch-spring. The operation of the tester will be understood by referring to the typical example shown in **3**.

Faults in the multiple due to disconnections are of course more readily located by means of tester type 5.

E.-in-C's. Drawing 1806 *and Diagram C.B.* 498. *Tester Type* 7. *Junction Circuits.*

This tester is 7½ by 6½ by 4¾ in., equipped with keys and lamps, etc., as shown in **4**, and is used in conjunction with tester type 4, for testing the junction circuits outgoing to, and incoming from, the various types of exchanges. Its object is to represent the conditions at the originating end as follows:

Battery on the ring and earth on the tip for circuits incoming from C.B. exchanges by operating key 1.

Balanced earth, for magneto and trunks, by operating key 2, and balanced battery for C.B.S. by means of key 3, *e. g.* the typical incoming junction circuit shown would be tested as follows:

First operation: Insert peg C into switch-spring D and arrange for the test clips to be joined up on the main frame.

Second operation: Represent the conditions at the calling exchange by operating key 1, and the 12 V. lamp should glow, proving the operation of the calling relay 200$^{\omega}$. Lamp B on tester also glows.

Third operation: Connect junction circuit-peg with switch-spring B on tester type 4, and the 12 V. lamp should darken, proving the operation of the cut-off relay 83·5$^{\omega}$. If lamps A and B glow when key 2 or 3 on tester type 4 is depressed, the supervisory relay 12·5$^{\omega}$ has operated. Tests *b* and *c*, referred to under tester type 4, should also be applied so as to prove the continuity and ensure that the adjustment of the supervisory relay is satisfactory.

E.-in-C's. Drawing 1829, *Tester Type* 8 (*Localising Lamp*).

This tester is merely a lamp-socket, suitably mounted, for accommodating a switchboard lamp of the voltage desired, and provided with an end cover to protect the cord connections. The two cords have a form of tie-clip fitted at the ends for readily attaching to relay-tags, cord terminals, wires, etc., when tracing faults in exchange plant.

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FUSE-BOARDS FOR LAMP-SIGNALLING TRUNK EXCHANGES.

By R. T. KING.

THE diagram shows the typical fuse-board arrangement now used in connection with large trunk exchanges of the lamp signalling type. The bus bars consist of high conductivity copper of cross section sufficient to carry the maximum current at a density not exceeding 500 ampères per square inch, and are mounted on slate which has been previously impregnated with an insulating compound.

The type of fuse used is of the alarm pattern, fitted with a bead indicator which is so arranged that when a fuse blows two springs are released, one of which actuates the relay of a local bell-circuit, and the other projects a bead threaded on spiral springs, by means of which the fuse to be replaced is readily located. In addition to completing the local bell-circuit, the former also causes a lamp to glow denoting the bus bar to which the blown fuse is connected. (See also 'Poole's Telephone Handbook,' p. 317.)

The type of fuse-wire used is such that it will carry two ampères indefinitely, but will blow with a current of three ampères in less than five minutes.

The bus bars are arranged to carry fuses 1¼ in. in length between mounting centres, and are slotted for No. 6 screws.

The relays used in connection with the generator bus bars are so arranged that when a fuse is blown the generator current circulating the relay coils causes a lamp to glow and the bell-circuit relay to be operated. If both the "A" and "B" fuse should happen to be blown simultaneously, the generator current passes through the relay coils in series. In the case of bus bars supplying current for "signalling," "speaking," and trunk circuits with intermediate offices, the lamps are connected direct; but for the ordinary trunks a relay is provided to meet night-working conditions, viz. when permanent current working is suspended and generator calling and clearing obtains throughout.

The lamps are shunted with a suitable resistance in order that the bell-circuit may not be disconnected should a lamp filament happen to be broken.

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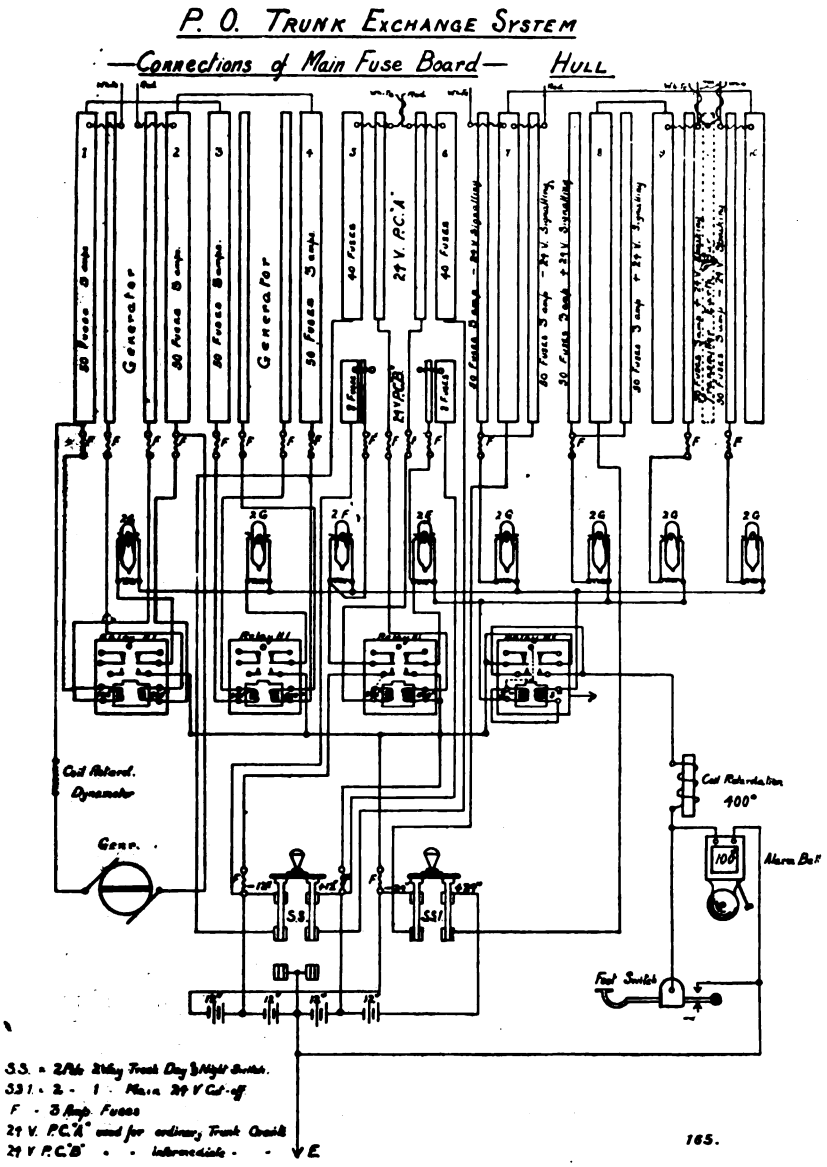

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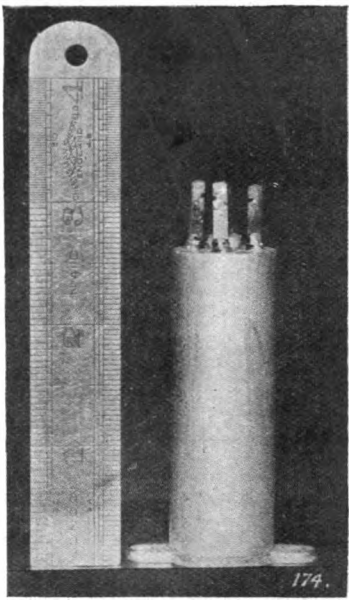
BREAKDOWN OF BRIDGING-COILS ON TRUNK CIRCUITS.

By F. ADDEY, B.Sc.

MUCH trouble has recently been caused on Trunk circuits by the breaking down of the insulation between the two windings of $200^{\omega} + 200^{\omega}$ bridging-coils. A view of such a coil is given in 1. The two wires are wound together, because on certain types of circuit the bridging-coil has to act as a transformer through which ringing currents have to be repeated. When the trouble was first noticed it was thought to be due to lightning, but from an analysis of the circumstances of numerous cases reported from all parts of the country, it appeared that in the greater number of instances these breakdowns took place without the occurrence of any storm. A suggestion was then made that the trouble might be caused by high voltages set up in the bridging-coils due to their inductance.



1.—BRIDGING COIL $200\omega + 200\omega$.

This theory has been investigated in the Research Section of the Engineer-in-Chief's Office, and, as will be seen by the results given below, it appears to be a very probable explanation of the difficulty.

The bridging-coil circuit investigated was that shown in 2. The essential parts of the same circuit, opened out for the sake of clearness, are shown in 3. The corresponding parts of the two diagrams have been similarly lettered.

It will be seen that when a peg is placed in or removed from the switchspring the points A and B in 2 are momentarily short-circuited. This allows a comparatively strong current to flow from the battery through the bridging-coils. When the peg is pushed home or completely removed this short-circuit is broken. The current in the windings of the bridging-coils is therefore suddenly stopped, and owing to the inductance of the coil a high E.M.F. is set up for a moment round the coils. It is this induced E.M.F. which probably causes the damage.

In the investigation referred to above, a Wheatstone transmitter

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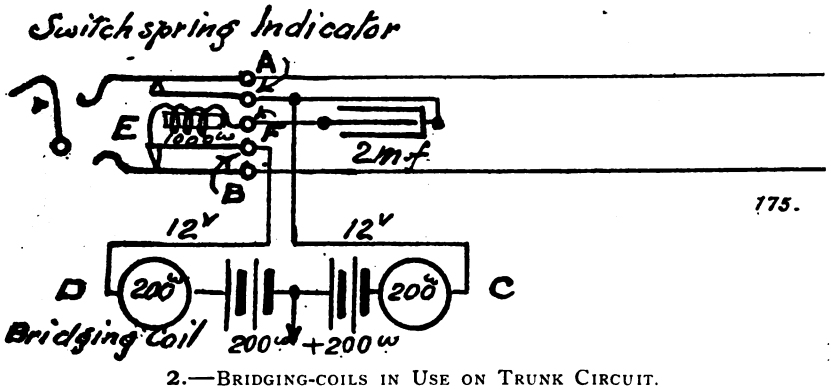
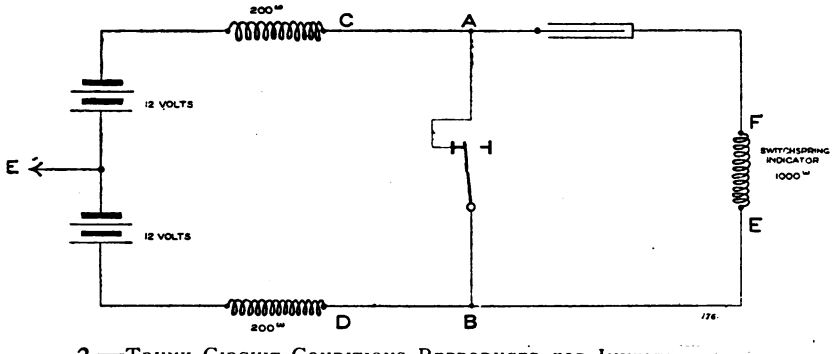
was joined between the points A and B (3) so as to produce a succession of short-circuits and disconnections, and the voltage and current in various parts of the circuit was examined by means of the oscillograph.

The two most interesting results obtained are shown in 4 and 5. In 4, the upper curve, marked A, shows the current at the point C (in 2 and 3), and the lower curve, marked B, shows the corresponding voltage across the points C, D (in 2 and 3).



2.—Bridging-coils in Use on Trunk Circuit.



3.—Trunk Circuit Conditions Reproduced for Investigation.

Consider Curve 4 A. At the end of the period of disconnection there is no current flowing at the point C, since the condenser is fully charged. When A and B are short-circuited, a path is provided for the battery to send a current through the two windings. This current does not rise to its full value instantly because of the inductance of the coils. At the same time the condenser discharges through the short circuit and the 1000ω indicator.

When A and B are once more disconnected the current at C drops suddenly to a small value, but continues flowing, decreasing in strength till the condenser is fully charged. When this state is

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reached the current at C ceases until A and B are again short-circuited. By comparing curves 4 A and 4 B, it will be seen that the voltage rises suddenly at the instant when the short-circuit is broken. The maximum displacement of the curve corresponds to an E.M.F. of 210 volts.

The current through the coils at the instant when the points A, B were disconnected was found to be 84 m.a., by measuring the displacement of the curve from the zero line.

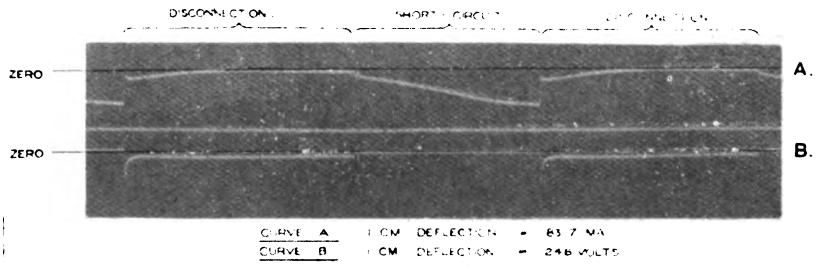

FIG 4.

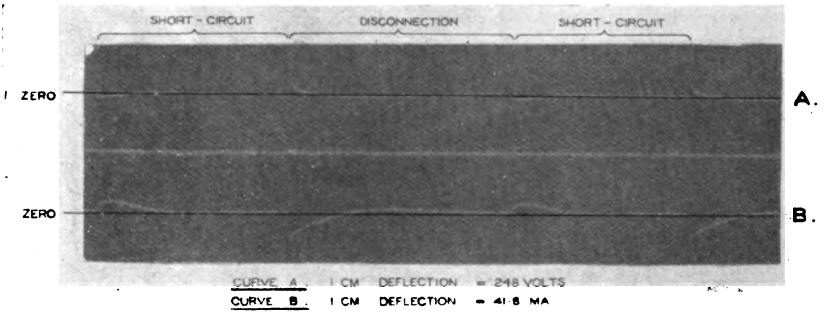

FIG 5.

4 and 5.—Oscillograph Records. Reproduced with Size reduced to $\frac{1}{2 \cdot 15}$ of Original. Measurements should therefore be Multiplied by 2·15.

The voltage between the terminals of the switchspring indicator was then investigated. 5 A shows the voltage between points E, F in 2 and 3. As would be expected from the curve 4 B there is in this case also a sudden rise in voltage when the short circuit between A and B is broken, in this case reaching 200 volts.

5 B shows the corresponding current at the point E. The following changes can be easily traced from the curve. While the points A, B are kept short-circuited the condenser is discharged. When the short-circuit is broken the high E.M.F. induced causes a rush of current into the condenser, reaching a maximum of about

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50 m.a. The condenser is now charged to a P.D. greater than the permanent P.D. at the battery terminals, and consequently it at once discharges until the P.D. between its coatings is equal to the E.M.F. of the battery. This discharge is shown by the curve passing to the other side of the zero line. When the P.D. between the condenser coatings has been thus adjusted, the current at the point E falls to zero until the points A and B are once more short-circuited.

When this takes place, the condenser discharges as shown by the curve 5 B, again passing to the upper side of the zero line. This discharge current, passing through the indicator coils, sets up a slight P.D. between the points E F, which is indicated on curve 5 A. When the condenser is completely discharged the current curve 5 B returns to the zero line, and remains on it until the short-circuit between A and B is again broken.

The finding of a remedy for this difficulty is now receiving attention.

SPEAKING DYNAMOS AND TRANSFORMERS.

(*From an article by Professor Peukert in the 'Electrotechnische Zeitschrift.'*

Translated by A. E. McCLOSKEY.

So far as can be ascertained the word "telephone" was first used in its modern significance in an article which appeared under the title of "Telephonie Electricale" in the 'Illustration de Paris' on August 26th, 1854.

In 1849 Charles Bourseul, an official of the French Post Office, predicted the transmission of speech. His words at this date seem almost prophetic: "Suppose that a man speaks near a movable disc, sufficiently flexible to lose none of the vibrations of the voice; that this disc alternately *makes and breaks* the connection from a battery; you may have at a distance another disc which will simultaneously execute the same vibrations." The words "make and break" form the keynote of the failures of those who subsequently followed Bourseul's directions literally. Bourseul's telephone is described in 'Expose des Applications de l'Electricite' by Th. du Moncel, which was first published in 1854.

As is well known, the first successful experiments resulting in the practical transmission of sound by means of electricity were made by Phillip Reis at Friedrichsdorf, Homburg, 1861–1863. The working of Reis's instrument depended upon the fact that an iron rod, when magnetised by a current, gives out a ticking sound. If the current be interrupted very frequently and regularly, and the rod be attached by its two ends to a sounding board or box, a musical note will be produced of a pitch depending upon the frequency

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of the breaks in the current. By such means the *pitch* of any sound may be reproduced at a distance: but this is not enough for the transmission of speech. Pitch is only one of the characteristics of sound, for, besides it, sound has *quality* or *timbre* and degrees of *loudness* or *intensity*, which it is necessary to transmit before human speech can be perfectly reproduced. This cannot be done by apparatus requiring for its working the application of interrupted currents. A simple musical tone is caused by vibrations of very simple form, while sound-waves produced by the voice in speaking are very complex in their nature. Reis's telephone could be depended upon to transmit only musical sounds. The question as to whether it actually did transmit speech has been the subject of much discussion, but if it did this at all it was very imperfectly. Reis is generally supposed to have been the discoverer of the telephone, but from the foregoing it will be seen that the claim must be regarded as doubtful. For the next fifteen years no apparent advance was made in the art of telephony, although several inventors gave it their attention.

In 1876 a perfect and surprisingly simple solution of the problem was supplied by the telephone invented by Bell and Gray, in which an undulating or induction current was employed.

I have recently conducted some experiments with a view to investigating the magnetic condition of an iron core acted on by undulating currents produced by speaking into a microphone. In the following notes this current will be referred to simply as "the microphone current."

A ring "*K*" (1) was constructed of soft iron wires, and round it was wound a coil of wire *I*, connected in series with a microphone *M*. When the microphone was spoken into "cross-talk" was heard in the iron. This was distinct, but so weak that it was necessary to place the ear very near to the ring before the words spoken could be distinguished. Now, it is known that the magnetism already possessed by a magnet will, under certain conditions, be considerably altered by comparatively slight variation in an adjacent magnetising force. This suggested to me the idea of placing the iron ring in a constant magnetic field, and this was accomplished by providing it with a separate winding *II* (1) connected to a battery. The result was most remarkable. On using the microphone loud sounds were heard issuing from the iron ring, and when the current in the magnetising coil was altered to a suitable value, speech became distinctly discernible at a few metres distant. As a variation of the experiment a coil with a soft iron core was placed between the poles of an electro-magnet, as shown in (2). Similar results were obtained, and as with the previous arrangement the loudness of the reproduction was found to depend very considerably on the magnetic effect produced by the permanent current. The "cross-talk" still took place, but with reduced intensity when a coil of wire without an iron core was placed in the magnetic field. When a coil of insulated iron wire was so placed speech was loud but less clear than when a similar core of copper was substituted.

As these experiments appeared to indicate that success depended on the maintenance of strong and constant magnetism in the iron ring, it was thought desirable to replace this electro-magnet by a permanent steel magnet. A coil

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with a soft iron core was placed between the poles of a powerful horse-shoe magnet and the experiments repeated. The previous results were excelled.

Experience having been gained in selecting the best forms and sizes of the component parts of such an arrangement, it has now become possible to place on the market a new telephone receiver (3) distinguished from all others in that it dispenses with the use of a diaphragm, and also by its general simplicity and efficiency.

The exceptional loudness of this receiver is explained by the fact that the magnetic circuit is almost perfect, and that the sound is produced by the simultaneous vibration of every molecule in a large mass of iron. The effect can be greatly enhanced by using a trumpet (such as is generally fitted to a gramophone) in order to concentrate the sound-waves.

With the old type of telephone difficulty as regards the transmission of overtones, which so much affect the quality of the sound, has always been experienced. In the new form of telephone this difficulty has been overcome.

Complaint is frequently made of the very unpleasant and even dangerous crackling noise produced by the diaphragm in telephones of the usual type whenever additional voltage is applied to the circuit, and also during ordinary switching operations when the circuit is connected with a C.B. exchange. Many attempts have been made in the past to effect a remedy by the use of special apparatus, but without success. With the advent of the new receiver the trouble has disappeared.

The iron core shown in 1 reminds one immediately of an alternating current transformer. Analogous experiments have been tried with different types of such transformers, all of which gave satisfactory results; everything that was sung or spoken into the microphone was reproduced by the transformer with great clearness, and so loud as to be heard with great distinctness in all parts of a large auditorium.

There was now no difficulty in conceiving that by an extension of the speaking transformer experiment one might succeed in making a dynamo talk. In any case it seemed worth while repeating all the previous experiments with such a machine (see 4). The field magnets were excited by a battery of accumulators and the brushes were connected to the microphone circuit.

The dynamo laughed, spoke, sang, and, in fact, repeated every sound made into the microphone.

A like effect was obtained from several other machines, dissimilar in size and form of winding. It was found that the loudness of the reproduction did not increase with the size of dynamo used. This is probably explainable by the fact that it is impossible to correspondingly strengthen the current in the microphone circuit.

That such large, compact masses of iron can be influenced by the weak currents of the microphone circuit is indeed a most interesting physical phenomenon.

After concluding these experiments I observed an article in the 'Electrotechnischer Anzeiger,' 1903, p. 174, in which mention was made that A. Kraetzer had already observed "cross-talk" in the transformers which he used while making experiments with the "singing arc." Kraetzer found that the

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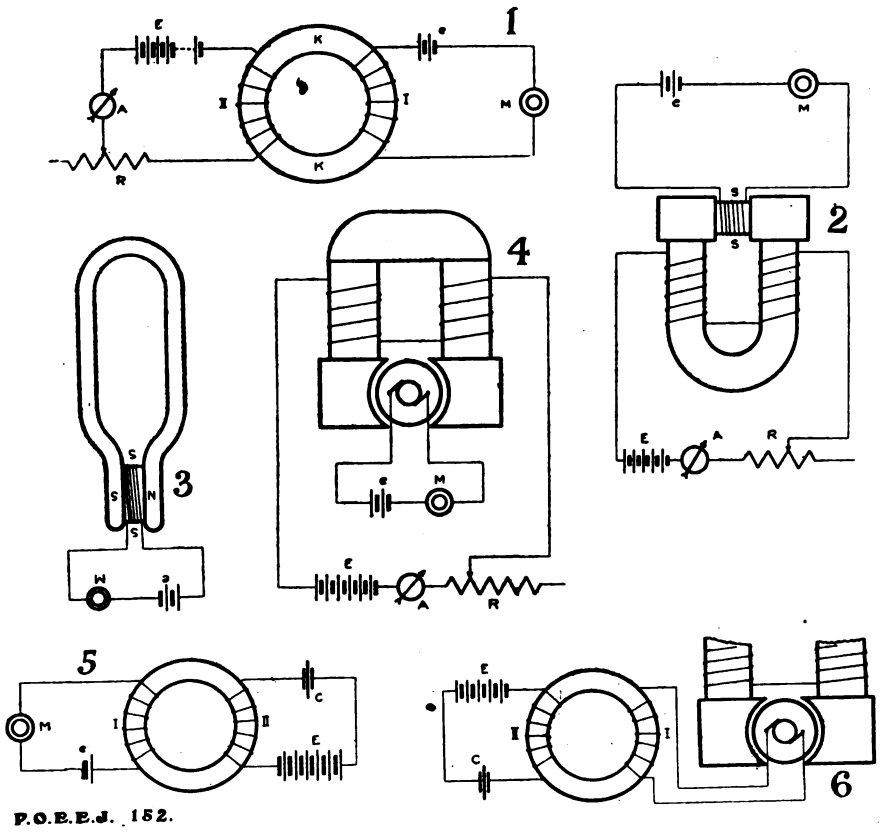
effect depended considerably on the constant maintenance of a magnetic density of a particular value in the transformer core.

For the sake of comparison it may be interesting to here describe some experiments which were made at Paris by Argyropolous with a speaking condenser.

In repeating his experiments I used the arrangement shown in 5. A single cell accumulator was connected in series with a microphone and with the primary coil " 1 " of a small transformer, the core of which was constructed



of iron wires. To the secondary coil " 2 " were connected a condenser " *C*" and a battery of accumulators having an E.M.F. of 300 volts.

When the microphone was spoken into the voice was reproduced by the condenser as perfectly as in the experiments above described. The condenser used was a 2 mf. plate condenser, in which paraffin paper is employed as the di-electric. The plates of the condenser were laid one above the other, but without additional pressure.

From the accumulator the condenser receives a constant charge at constant P.D. The action of the microphone induces in the secondary coil a varying E.M.F., which is superimposed on the constant pressure due to the main

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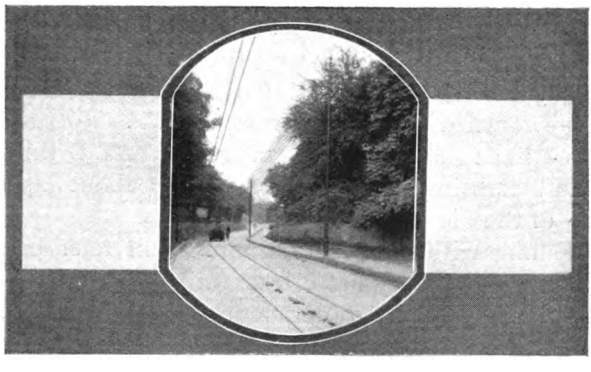
battery. If the former be called "e" and the latter "E," then the attraction between the coatings of the condenser is proportional to—

$$(E + e)^2 = E^2 + 2Ee + e^2.$$

The variable attraction between the coatings depends on the quantity $2Ee + e^2$, and can be strengthened at will by choosing a suitable value for E.

The vibrations in the condenser correspond exactly with those produced in the diaphragm of the microphone by the sound-waves impinging on the same. If the plates of the condenser are greatly compressed the sound ceases, and it is scarcely discernible if the main battery is switched out and the condenser left connected alone in the secondary circuit.

By means of the speaking condenser the pressure pulsations in a D.C. dynamo can be observed. Such pulsations are always present; they can never be completely eliminated, though their effect may be lessened by increasing the number of segments in the commutator. When it is desired to make the voice reproduction as clear as possible, the main voltage must be kept absolutely constant. For the reason already referred a dynamo is unsuitable for such a purpose, and I therefore made use of the experimental arrangement shown in **6**. The brushes of a dynamo (accumulator excited) were connected to the primary coil of a transformer, the secondary coil of which was connected with a battery and condenser as in the previous experiments. The sound from the condenser could be heard at a great distance, but ceased immediately the exciting battery was removed. The reason for this will be readily understood from what has already been stated.



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POWER SUPPLY AT A REPEATER STATION.

By E. A. LAKEY.
Repeater Station, Nevin.

REPEATER instruments are inserted in telegraph circuits to increase the speed of working. Since the speed of working varies inversely as the square of its length, by the insertion of a repeater at the half distance on a long telegraph wire the speed of working is practically increased fourfold, and the repeater office becomes as it were a terminal office.

Away in the wilds of Wales, on the north coast of the beautiful Lleyn peninsula (Carnarvonshire), the nearest railway station being at Pwllheli, seven miles distant, is the Morfa Nevin (NV) repeater station. This is the most remote of the five repeater offices controlled by the Engineer-in-Chief. The others are at Haverfordwest and Llanfair P.G. (Anglesey) on the Irish routes, and at Lowestoft and North Walsham on Continental routes. It will be apparent that the location of these offices was determined by their proximity to the cables, and their remoteness is due to the fact that the landing-point for a cable must be away from the routes frequented by those who go down to the sea in ships.

At Morfa Nevin eleven wires are brought in to the repeaters. Nine of these are Wheatstone Duplex repeaters, and two are quadruplex repeaters. On the duplex sets the standard speed is 300 words a minute each way; and for simplex working 400 words a minute. The quads. are worked between London and Dublin. One is a Key quad., and the other has Wheatstone apparatus fitted on the "A" sides; and full quad. can be worked with the transmitters running at about seventy words a minute. The first Irish news is one of the wires relayed at NV; and the average working speed on this wire is 250 words a minute. On a busy Parliamentary night four or five news wires are often in relay at NV.

Secondary cells have now been fitted up at this office for telegraph and lighting purposes, replacing about 2500 primary cells, mostly of the bichromate type.

Before dealing with this installation I will refer briefly to the old conditions with primary batteries.

Each duplex repeater required four sets of main batteries and two sets of local batteries, the latter for the automatic switches and sounders respectively. The main voltages varied from fifty to one hundred, according to the wire.

Two sets of main batteries—*i. e.* a battery earthed in the middle—were required for each side of the repeater, all wires being worked on the double current principle. Perhaps I should here refer to the

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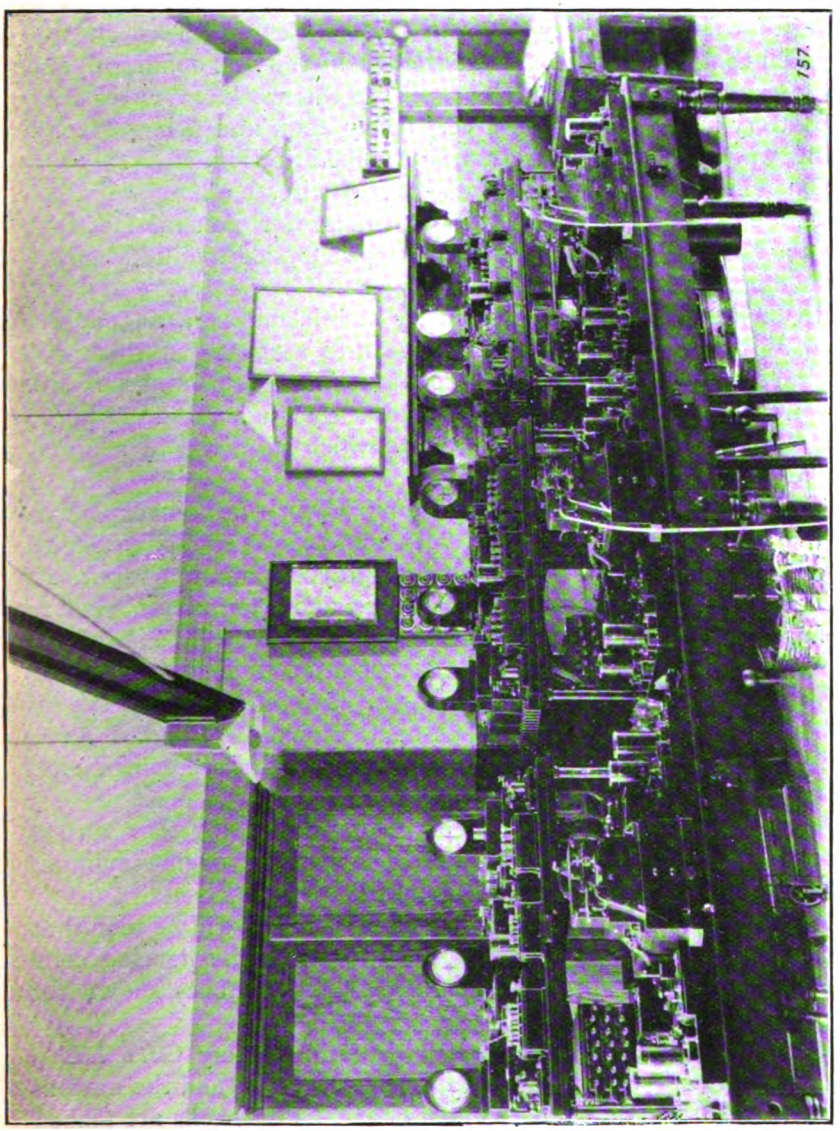

MORFA NEVIN REPEATER STATION. VIEW IN INSTRUMENT ROOM SHOWING THREE DUPLEX FAST SPEED REPEATERS, AND THE ELECTRIC LIGHT SWITCHES. THE LAMP RESISTANCES CAN BE SEEN BETWEEN THE REPEATER BOARDS.

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nomenclature of these batteries, which is often misunderstood. The "up mains" work to the "down station," and the "down mains" to the "up station."

The quadruplex repeaters had eight sets of main batteries and six sets of local batteries.

With this multiplicity of primary batteries and leads it was essential that they should be maintained in the best condition, and a batteryman's time was fully occupied in this work.

Battery maintenance was a very heavy item, and a large factor in this was the cartage charges from Pwllheli Station.

The office was wired with G.P. covered wire.

In mentioning the old conditions I must not omit the fact that two 100 C.P. "Veritas" paraffin-oil lamps supplied the illumination of the office.

In connection with the secondary cell installation, an engine-room 20 by 14 ft. was built with a lean-to roof against the main building, and a 3-feet concrete base laid for the engine and dynamo.

Power is obtained from a Crompton dynamo, rated at 90/60 volts, 39/58½ amperes, and 275 r.p.m., which is driven by a direct coupled 7½ h.p. Hornsby's oil engine.

This engine works on the Otto Four Cycle—*i. e.* one explosion for two revolutions of the crank. Russian refined oil, sp. g. ·822 to ·825, is converted into vapour by being sprayed into a hot vaporiser. The vaporiser is first heated by a lamp for about ten minutes before the engine is started, and is maintained hot by subsequent explosions. The explosion is obtained by the compression of fresh air mixing with the vapour already in the vaporiser. The flash-point of the oil is about 90° Abel test, or 100° open test. For a day's run of seven hours the consumption of oil averages about 3½ gallons, costing 2*s.* 4*d.* or one halfpenny per horse-power-hour.

The power board is also in the engine-house, together with a large water tank for circulating water round the engine cylinder jacket.

A diagram of the power board is given in 1. It will be seen that the magnetic cut-out on this board is in use when the lighting cells are charged. These are also controlled by the switches shown for charge and discharge.

The lighting battery consists of 33 D.P. Battery Co.'s LL 9 cells. The charge-rate for this type is 32 amperes, and the normal discharge-rate is 24 amperes for ten hours. These cells are placed on a double-tier pitch-pine rack in the corner close by the engine-room, the cabling connecting to the power board being taken through the wall a few inches higher than the latter.

They supply current to 60 volts 13 c.p. Tantalum lamps, of which there are 3 in the engine-room, 12 in the battery room, 1 in the

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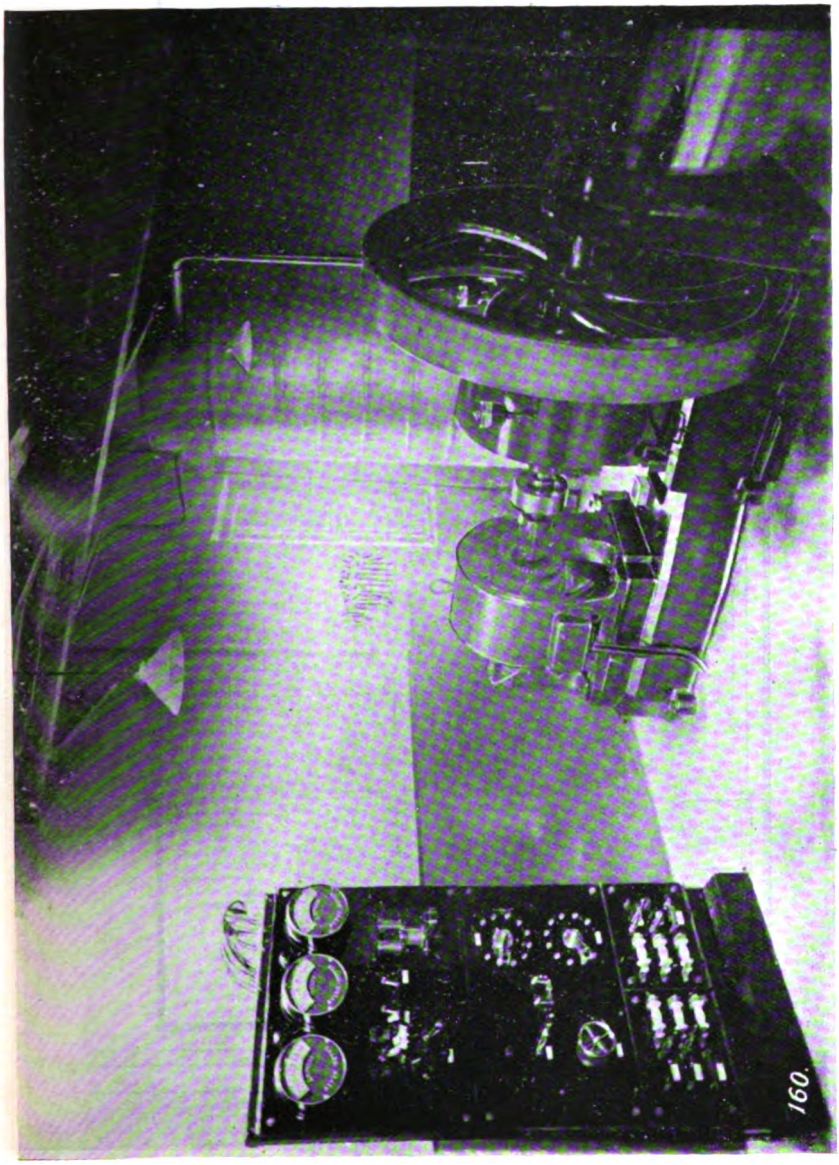

[Morfa Nevin Repeater Station. Oil Engine, Dynamo, and Power Board.

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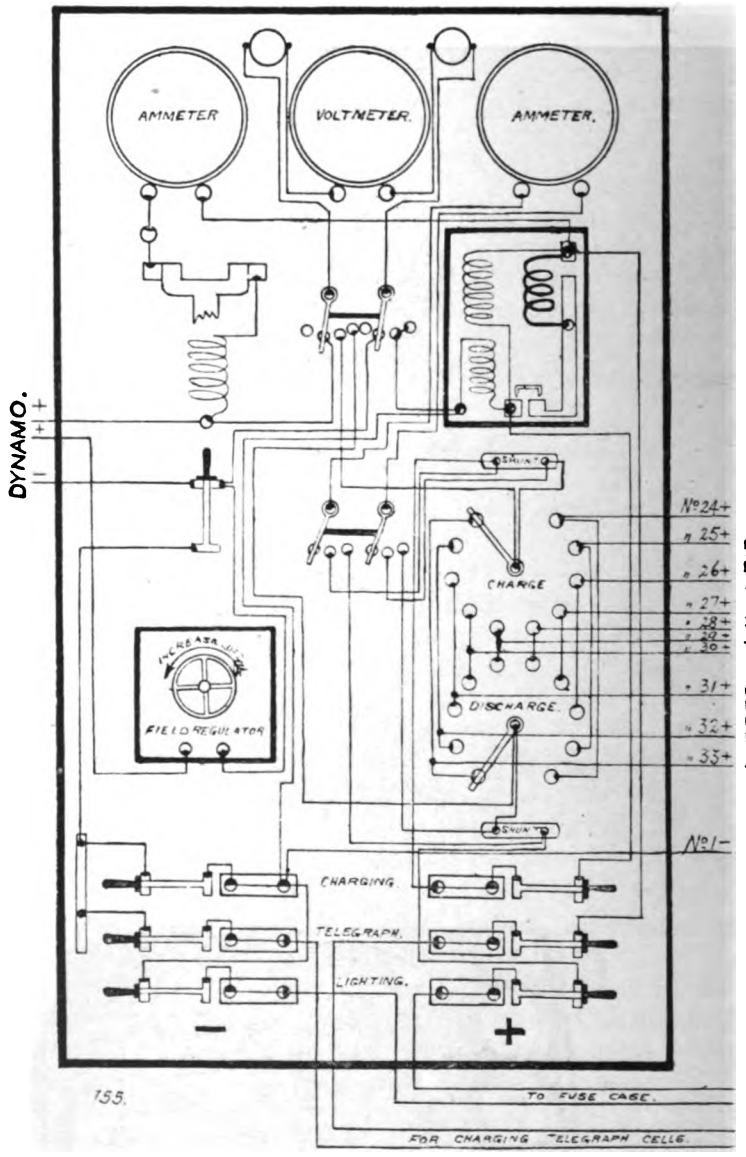
store room, 20 in the instrument room, 1 in the retiring room, and 1 on the staircase. There are also 8 wall-plugs.



1.—Power Board Connections.

For telegraph working there are 209 Hart cells, type T9 90 ampère-hours. These are controlled from the usual battery-room switch cabinet. The leads from the dynamo for charging these cells (cable E.L., impregnated 19/16) pass from the power board

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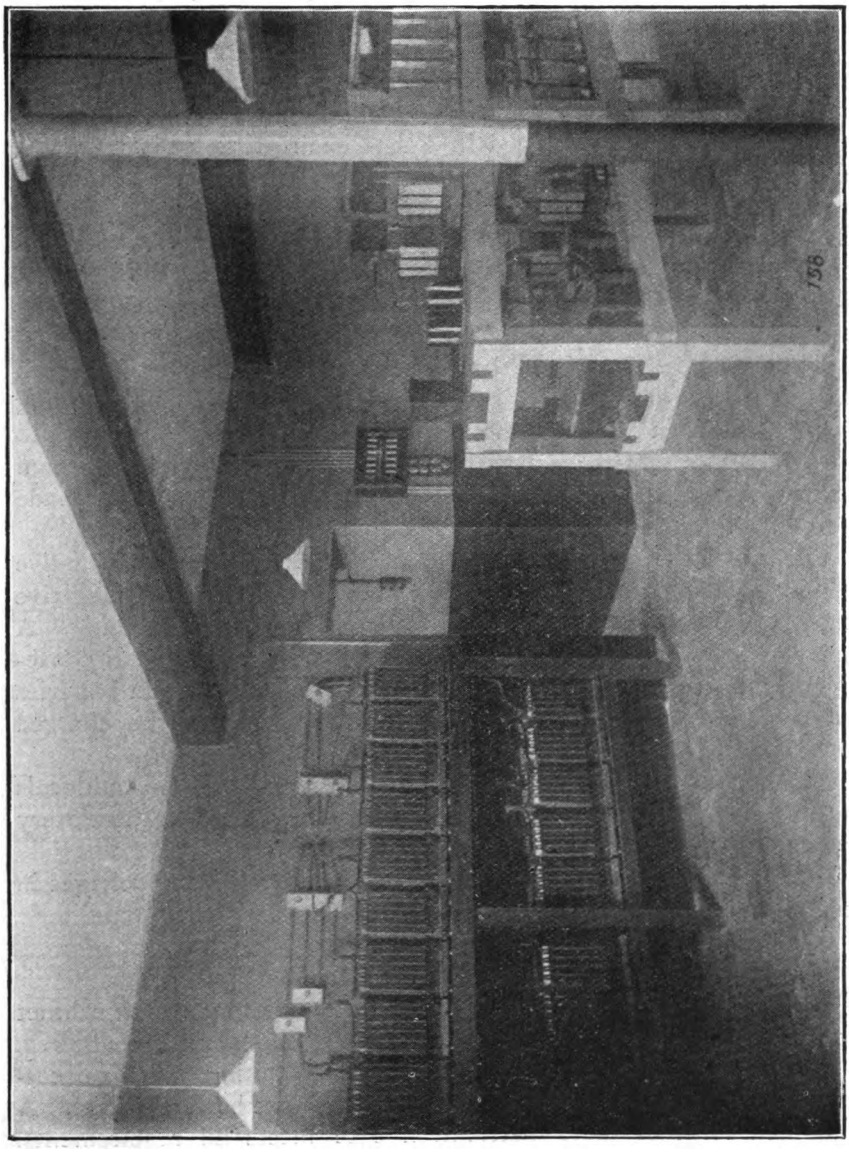

MORFA NEVIN REPEATER STATION. ACCUMULATOR ROOM.

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to an accessory board, thence to the battery-room switch cabinet. This accessory board supports the magnetic cut-out for use when the telegraph cells are being charged, and a bare wire resistance placed near it is also in use when a group of telegraph cells are charged in parallel with the lighting cells.

The telegraph cells are arranged on two racks of white pine, one 25 ft. long, and the other 20 ft. long. The longer rack contains the negative mains arranged in 4 sets of 20, together with the positive and negative locals arranged in 2 sets each of 12 cells. On the shorter rack are the positive mains made up in 3 sets of 20 cells and one set of 21 cells. The additional cell in this case is the spare, so that a cell is always available in case of emergency. On this rack are also placed the Daniell cells for the Wheatstone Bridge tests, the standard cell, and the additional dry cells for the morning testing arrangements to bring the voltage up to the required 55·5.

The connections of the battery room switch cabinet are such that a positive and negative set of mains are available for charging in parallel from the dynamo, whilst the remaining 3 sets of 20 positive and 3 sets of 20 negative are joined to the instrument room leads. A rotary switch admits of these transpositions being made without disconnection from the instrument room leads.

As the local cells are also in duplicate, a positive and negative set are available for charging whilst the other positive and negative sets are in use. The locals are joined in series for charging. A small variable bare wire resistance (2^{ω}, $1{\cdot}3^{\omega}$, $1{\cdot}0^{\omega}$, or $\cdot 6^{\omega}$) is consequently placed in each of the parallel leads of the main batteries when charging in order that mains and locals may be charged together.

Under working conditions the − pole of the + mains and locals and the + pole of the − mains and locals are earthed at the battery room switch cabinet.

The arrangement of the cells provides the following voltages in the instrument room:

+	24	40	80	120
−	24	40	80	120

Altogether 10 leads are taken up from the battery switch cabinet to the instrument room; hence there are two spare leads.

In the instrument room, as only one distributing point is necessary, the usual main distributing cabinet has not been provided. A modified form of table distribution case meets all requirements. This is similar to the table distribution case as far as the provision for 1-ampère fuses goes; but it is somewhat higher. The additional space at the top provides positions for the 5-ampère fuses usually placed in the main distributing cabinet.

2 gives a diagram of the external wiring of a Wheatstone Duplex

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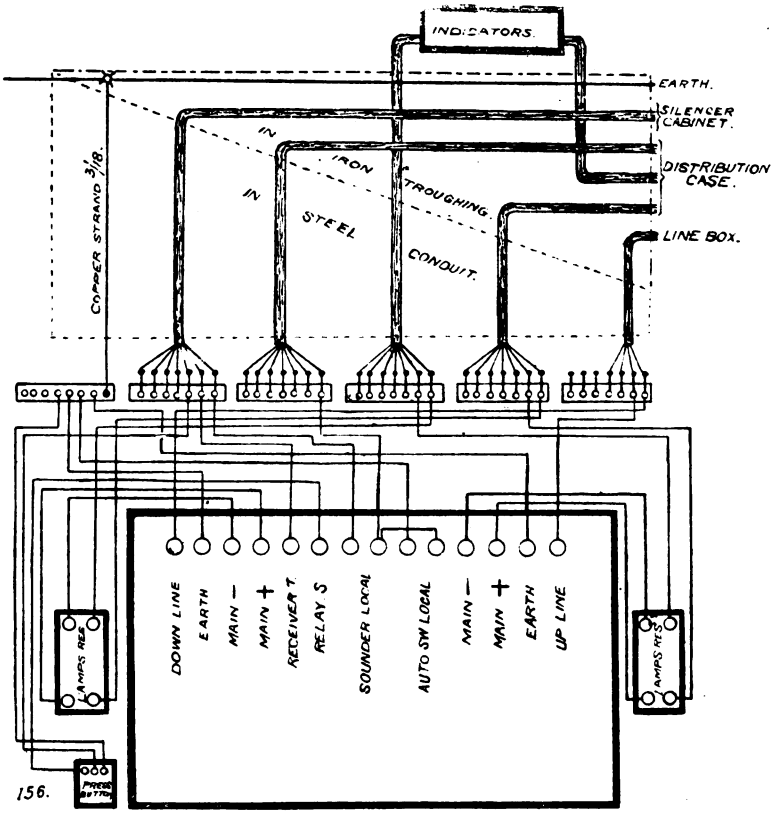
Repeater of the standard pattern with the cable on the down side. These repeaters are either for duplex or simplex working. The up side is worked differentially, and the cable side on the Bridge system when at duplex.

Cable S & C Core 4/20 or 7/20 as most convenient has been used for distribution in the instrument room. These cables are laid in the usual iron troughing under the floor, and in two runs between the joists, one on each side of the room and as far as possible under



2.—External Wiring of Wheatstone Duplex Repeater.

the instrument tables. The main earth wire (copper strand 7/18) is also run in the troughing. The cables are taken up to the tables in steel conduits and are terminated under the tables on connection strips (seven tags). From these flameproof wires 1/20 complete the connections to the repeater board terminals.

The main negatives are first taken from the distribution case to the indicator board. An indicator is placed in each of these leads to give intimation by the ringing of a bell when the batteries short-circuit at the relay points. An additional indication of this is also

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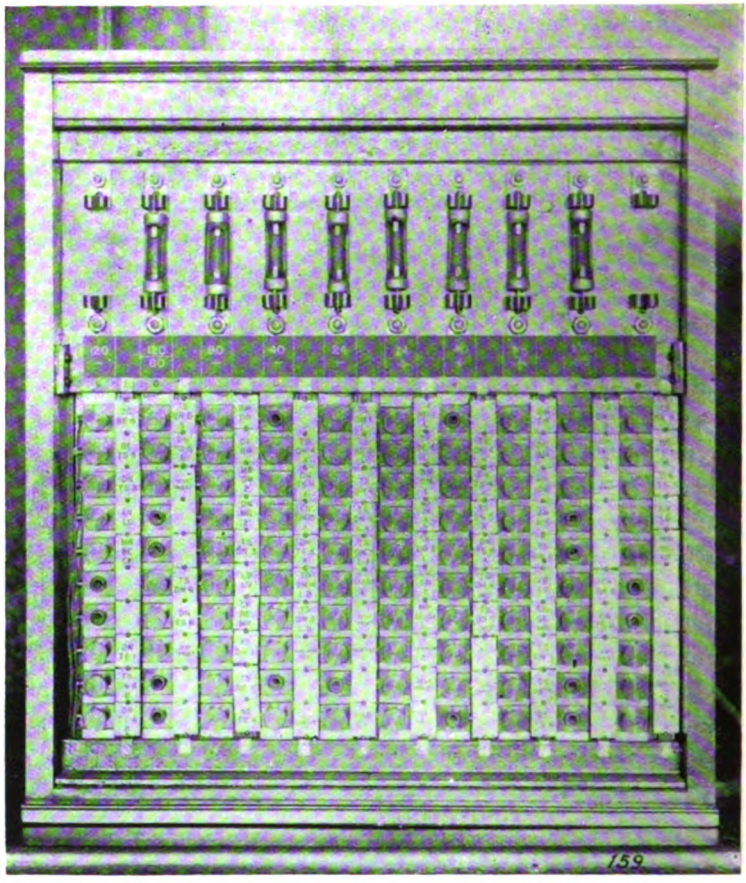
given by the illumination of the lamp resistances, one of which is placed in each battery lead (see **2**).

The load on the locals is pretty evenly divided by distributing the + down one side of the instrument room and the — on the other side. The sounder silencer cabinet has 12 electro-magnets of 1000ω shunted by 1000ω taking current from the locals. It was



3.—Fuse and Distribution Case.

deemed expedient to divide the bus bar of this so that five of them are worked from — locals and 7 from the + locals.

The distribution of the voltages will be seen in the photograph of the distribution case which was taken with the glass front off (**3**).

The wiring for lighting is on the looping-back system with a maximum of eight lamps or wall-plugs on a branch.

Cable EL IR vulcanised 7/23 is run from the fuses for the first five lamps, and then cable EL IR vulcanised 3/22. The cable

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is enclosed in steel conduit in the battery room, etc., downstairs, and in wood-casing in the instrument and retiring rooms. In the instrument room the lamps are connected to the ceiling roses by wire EL Flexible Twin S.C. 40/40, and elsewhere by wire EL Flexible Workshop.

In conclusion, I may add that a similar installation was put in the Llanfair P.G. Office about the same time, and both transfers took place without a hitch.

The change is greatly appreciated by the respective staffs. Troubles due to battery failures have disappeared, and telegraph working is in consequence brought as near perfection as possible. The chief troubles now are due to line faults and slight instrument failures, as no automatic system is infallible.

The introduction of the electric lighting, too, is a great boon. Checking the signals recorded on the Morse slips is no longer such a strain on the eyes, and the delicate adjustments of neutral relays, etc., can be more readily carried out, as the system of lamp distribution is all that can be desired.

A METHOD OF REDUCING INDUCTIVE INTERFERENCE BETWEEN WIRE AND WIRE OF A TELEGRAPH CABLE BY MEANS OF CONDENSERS.

By A. C. Booth.

The device about to be described was brought into use in July, 1901, at the Post Office repeater stations of North Walsham and Lowestoft, for the submarine cable portion of the Anglo-German circuits which pass through those offices.

The Hughes apparatus on the circuits had been duplexed in 1898, and, although at times giving excellent results, there were periods of difficulty due probably to the cumulative effect of minor defects. It was therefore considered advisable to increase the working margin of the most difficult section, viz. the submarine portion, between the repeater stations on the English side and the repeater station at Emden on the German side. These are the longest submarine cables belonging to the Post Office, being roughly 300 miles in length, with capacities ranging from 71 to 93 microfarads, and resistances from 1600 to 2700 ohms. There are five cables each having four separate conductors, and although in some cases each conductor is separately wrapped with brass tape, the signals on one conductor produce a very pronounced effect on

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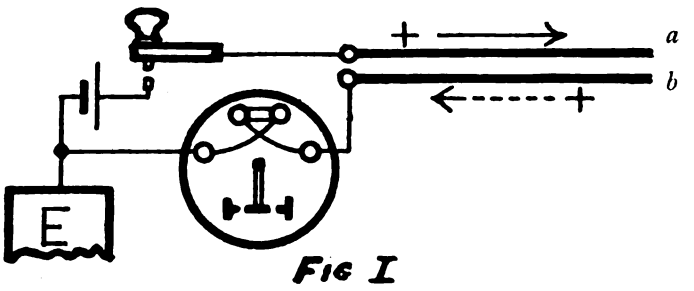

FIG I

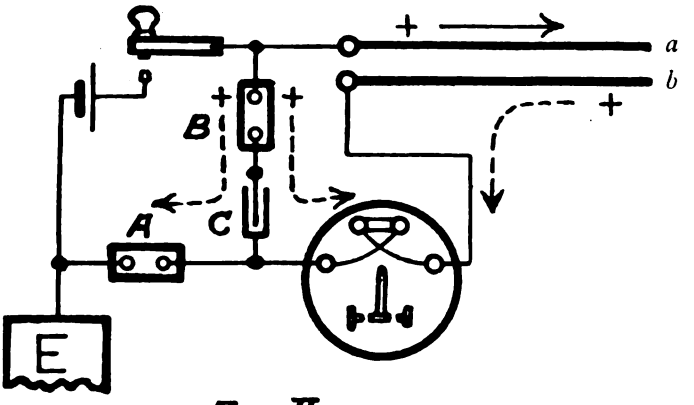

FIG II

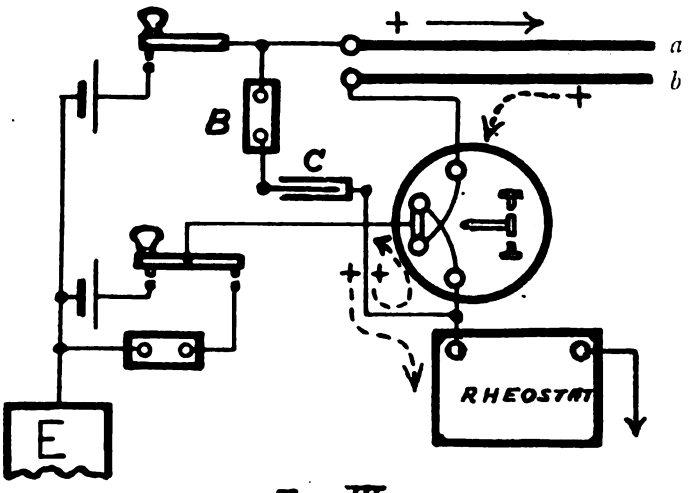

FIG III 161.

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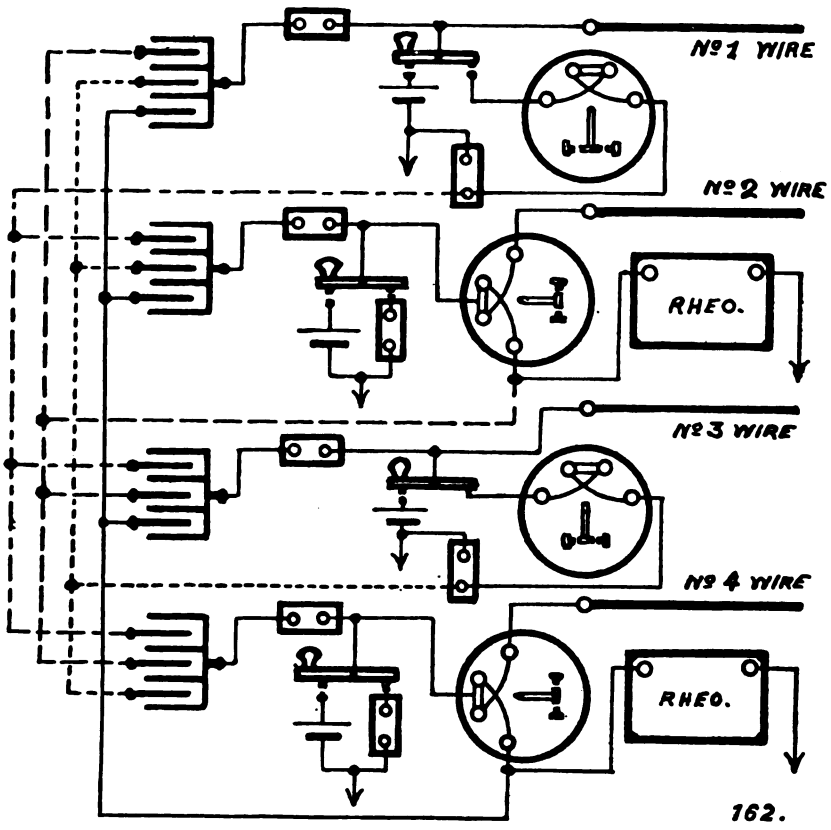
its three neighbours. This effect was not sufficient to cause any noticeable trouble with Hughes simplex working, although no doubt helping in that direction when other minor apparatus or line defects existed.

If *a* and *b* in 1 are two conductors of a cable, then a current in *a* produces a momentary current in the reverse direction in *b*, tending to quicken or retard the movement of the relay tongue according



4.—Connections for Four Cable Circuits.

to the direction in which it is moving and the direction of the induced current.

It is obvious that if a momentary EMF equal in every respect to the induced EMF could be applied to the relay in the opposite direction at precisely the right instant the effect on the relay would be *nil*. On simplex circuits this momentary opposing current is obtained by adding a resistance coil between the relay and the earth of the disturbed circuit, and connecting a condenser between the disturbing conductor and a point between the relay and the resistance coil of the disturbed circuit. 2 illustrates the connections:

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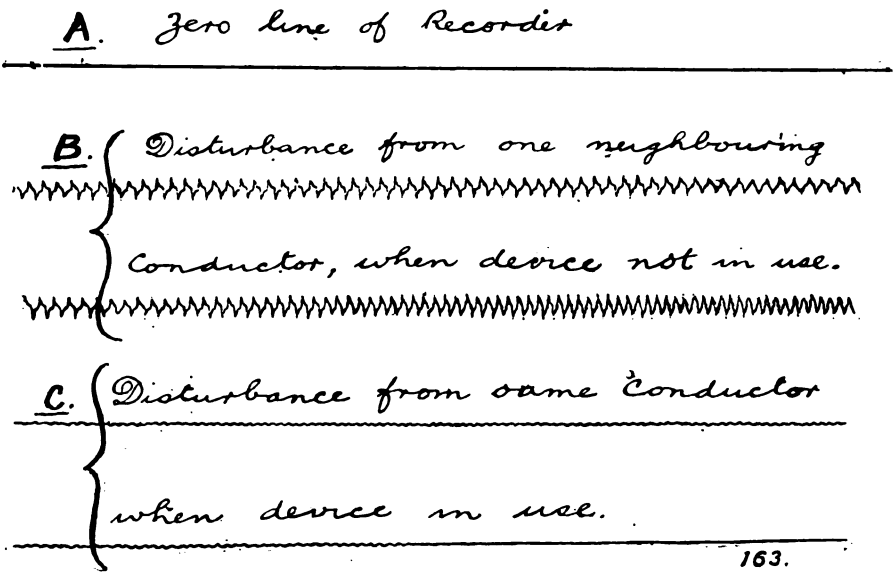
A is the additional resistance coil placed in the disturbed circuit, *c* is the condenser, and *B* is a regulating resistance in the condenser circuit. The values of all three are obtained by experiment; *A* is in hundreds of ohms, *B* is in thousands of ohms, and *C* ranges from about ·2 to 1·2 microfarads, depending on the particular cable and apparatus employed.

When a current is sent into the disturbing circuit a momentary current is induced in the disturbed circuit; also a momentary current passes from the condenser, dividing between the resistance to earth and the relay of the disturbed circuit and neutralising the effect of the major portion of the induced current.


A. Zero line of Recorder
B. Disturbance from one neighbouring
Conductor, when device not in use.
C. Disturbance from same Conductor
when device in use.
163.

5.—Syphon Recorder Slip showing Elimination of Disturbance.

For duplex circuits a slightly different arrangement is required. The condenser is joined to the disturbing circuit as before, but is connected to a point between the relay and rheostat of the disturbed circuit (see 3).

When a current is sent into the disturbing circuit, a momentary current passes through the line coil of the relay of the disturbed circuit; also a momentary current passes from the condenser through the compensating coil of the relay in a direction to oppose the effect of the momentary induced current in the other coil.

As all four wires of each cable have to be protected from the other three the connections become somewhat involved, but can be readily traced in 4 by reference to 2 and 3.

5 shows slip obtained from a syphon recorder joined across the

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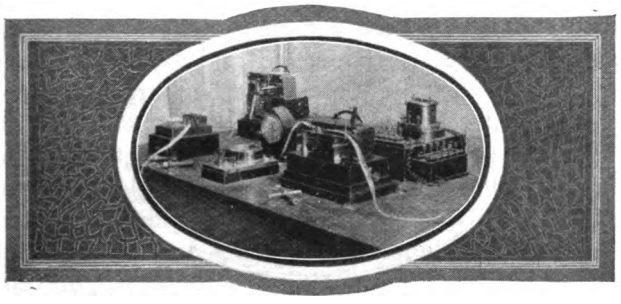
coils of the relay in a disturbed circuit. In the first case, the device was not in use; in the second case no alteration of any sort was made beyond joining up the arrangement described.

Although first permanently installed on the working lines of the Post Office in 1901, as already stated, the device was not new, and I am unable to state to whom the idea is due. Mr. J. E. Taylor, of the Engineering Department, used the same principle in a smaller degree in the year 1900 at Ballycastle Post Office, to neutralise the inductive disturbance on the Admiralty telephone circuit between Ballycastle and Torr Head coastguard station, produced by operating the transmitter in the circuit for communicating from Ballycastle to Rathlin Island on the "electro-magnetic system" of wireless telegraphy. The capacity necessary to give the desired result was extremely small in this case, and was obtained by using a few yards of twisted cotton-covered and paraffined twin wire By cutting down the twisted twin wires to a suitable length the correct capacity was readily obtained. Temporary use of the device had also been made by Mr. Taylor in the Liverpool Trunk Exchange in 1895, for the purpose of eliminating induction between circuits running from the basement to the second or third floor of the building. It should be pointed out, however, that so far as telephone circuits are concerned the device can only be made use of on very short circuits. On longer circuits the phase and character of the disturbing currents are so changed that a sufficiently close "copy" of the induction cannot be made by any simple method of using condensers, leaks, or mutual induction.



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SOME IRISH WAYLEAVE EXPERIENCES.

O obtain wayleaves in this country is much easier than across the Channel, where the public are fully aware of their power to get a *quid pro quo*. In Ireland the people have a kind of idea that "the Government" can do whatever it likes, and so far as the work of this Department is concerned—which is always for the good of the public—it would be a pity to disabuse them of this idea.

If you approach a farmer, or other of his class, with a wayleave form he at once regards you with suspicion, which doubtless arises from hereditary distrust of a blue paper in any shape or form. To induce such a man to sign the form calls forth all the powers acquired from a faithful observance of the ceremony of "kissing the Blarney Stone."

Talking about blue papers reminds me of an experience I had in West Cork a few years ago. A telegraph extension was authorised to a village about thirty-five miles from a railway station. As I had to make up the estimate I thought it would save time and expense if I left the usual notices at the half-dozen or so houses along the road. After inducing someone at each of the three first houses to accept one I approached the next. Whilst steadying my bicycle against the broken-down cart-wheel which did duty as a gate a crowd of bare-footed children, pigs, hens, a goat, some geese and a gander collected, watching me with interest. Immediately I took the "blue" paper out of my pocket the children bolted for the cabin, followed helter skelter by the rest of the community, with the exception of the gander, who hissed defiance at me. As I went up the track the door of the cabin opened and two men came out to "welcome" me with a fierce-looking lurcher straining on a ragged piece of rope. With difficulty I convinced them that I was not trying to serve the process they were daily expecting for a trifle of seven years' rent which was due. After sympathising with them on the "injustice" with which they were threatened they accepted the form. We parted such good friends that one of them insisted on accompanying me to the remaining cabins to prevent further probable misunderstanding.

On one occasion we erected a pole in a field without permission. The next day the owner of the field in a great state of excitement saw the foreman, and said he "would not be responsible for the pole." "Shure, we won't hold you responsible," said the foreman, "but you

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might keep an eye on it so that the young blayguards won't be throwing stones at it." "Shure, if that's all, sir, I'll do it aisy and welcome," said the farmer. Up to the time I left the district no damage had been done to the pole, and the man seemed proud of the trust placed in him.

Private wayleaves in towns are much more difficult to negotiate than those in the country. One has to persuade a man that he is getting something in exchange for a favour which costs him nothing, or, as a last resort, appeal to his sense of public spirit. I remember we wanted permission to attach some wires to the chimney of a bank. One of my assistants—whom I knew to be a very plausible person—was sent to see the manager. After explaining what we required, the manager said, "Well, why should I let you put your wires on my building and have your men walking about the roof at all times? Where do I come in?" "I noticed," said Mr. —, "that there is no lightning protector on your building. If you allow the wires to be attached to the chimney you will be provided with a most efficient one free of cost." We got the wayleave. I may add that this same assistant was invariably successful in obtaining wayleaves or pacifying unreasonably irate subscribers.

W. M. EVANS.

THE ORIGIN OF T.S.

We append a letter which we have received from Mr. F. E. Baines, who claims to have been the inventor of the world-famous code for the C.T.O.; and we have registered a vow to have the code in future invariably printed as Mr. Baines directs.

The general impression appears to have been that TS was adopted from the initials of Telegraph Street, where the various London offices which had been acquired from the Companies were first concentrated. Perhaps, however, this is a case where cause and effect have been confused. Mr. Baines may lay claim to "telegraphic" fame on other grounds than on this "invention." Immediately after the transfer of the telegraphs from the Companies to the State he made a most exhaustive survey of the Kingdom with a view to the reorganisation of the traffic routes. His reports were printed in a series of chapters, and came to be known as "Baines' Chapters." Bound copies of the work are still retained in the Post Office archives, and it may be added without flattery that they are models on which modern reports might well be fashioned.

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To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

"HONOURED SIR,—By favour of one of the Superintending Engineers (who, it seems, I had the good fortune to introduce into the service about forty years ago), I have had the privilege of perusing some parts of that very admirable publication, THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

"It is not my object in this short note to comment on the illuminating articles which that journal contains (though I may permit myself to express both admiration and regret—the former at the tone and substance of those articles and the testimony they bear to the truly astounding advance of technical knowledge achieved in your branch of the department, and regret that I am no longer associated with it), but to point to a minute error of the press—too insignificant to have arrested your attention—viz. the insertion of full points in printing the arbitrary equivalent of the Central Telegraph Station 'T.S.' is wrong. It is not the abbreviation of 'Telegraph Station,' it is the telegraphic name of the office—'TS'—where the apparatus is centralised.

"'The St. Martin's le Grand Magazine' had fallen into this error, and the editor, with a gracious humility, accepted the correction; though whether he has mended his ways I know not.

"As the inventor of 'TS,' may I, with much diffidence, lay this statement before you?

"Your obedient and humble servant,

"F. E. BAINES

"(who once had something to do with Post Office Telegraphs)."

"P.S.—'T.S.F' (as I think the Foreign Gallery is named) stands probably on the same footing—though, perhaps, it really means 'TS No. 2.' But I have not yet been able to give that complex problem the attention which its importance deserves, and I had nothing to do with its inception.—F.E.B."

THE ORIGIN OF THE SYMBOL "O.K."

THE origin of the use of the letters "O.K." is a subject which has often been brought up for discussion. Mr. James D. Reid, who died in 1901, and who during his lifetime was often affectionately spoken of as the "Father of the Telegraph," having associated himself with Professor Morse in 1845, gave the following account as his understanding of the first use of these characters:

"There is a little obscurity about the first introduction into literature of the characters O.K. They originated, it is believed, in the answer of a Southern postmaster to a communication from Washington to which he

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replied 'Oll Korect,' and which caused much amusement at the time, as the communication had some relation to the retention or loss of his head. This was in 1839, or early in 1840. In the Maine campaign of 1840 the Democrats of Portland arranged with the captain of the Boston steamer to place the letters 'O.K.' on the wheel-house of his boat if the elections were going all right for the party, which many interpreted 'out of kole.' Its first use on a commercial telegraph line was in January, 1846, on the line of the Magnetic Telegraph Company, of which I was superintendent, and was as follows: 'To prevent all doubt of the reception of messages, no message will be regarded as received by the office to which it has been transmitted until the signal O.K. has been received acknowledging its reception.' The same signal was used on the Government experimental line in connection with the repetition three times of the letters i. i. i. i. i. i. O.K. The signal soon became universal."—'Telegraph Age.'

ABSTRACTS.

UNITED STATES TELEGRAPH AND TELEPHONE STATISTICS.

THE following statistical summary, abstracted from the 'Electrical Review and Western Electrician,' shows the present position of the telephone and telegraph systems in the United States:

The capital invested in the telegraph and telephone business in this country is in excess of a billion dollars, £169,711,667 in the telephone systems and £45,894,495 in the telegraphs. According to the third census of the electrical industries, made by the government, there is a grand total of 15,072,220 miles of single wire in the telegraph and telephone service. Of this, the telephone systems controlled 12,999,369 miles, of which there were on pole or roof lines 5,002,223, in overhead cables 2,917,114, in subways or conduits 9,469,302, and in submarine cables 20,730 miles. Of the grand total stated, the telegraph systems, exclusive of government telegraph systems, used 2,072,851 miles, of which there were on pole or roof lines 1,958,336 miles, in overhead cables 41,886, in subways or conduits 65,347, and in submarine cables 7,382 miles. These figures emphasise the economic importance of the telegraph and the telephone.

A comparative summary deals with the elephone and commercial telegraph systems, not including railroad lines and the wireless, giving the grand total as 22,996 companies, of which there are 22,971 telephone systems, which include 17,702 independent farmer or rural lines and twenty-five commercial telegraph systems, not including the wireless. The grand total of single-wire mileage was 14,570,142, of which the telephone systems controlled 12,999,369 miles, which include 486,294 miles of wire on independent farmer or rural lines, while the telegraph systems used 1,570,773 miles, exclusive of 7,188 miles of leased wire.

The grand total of ocean cable was 46,301 nautical miles, all controlled by the commercial telegraph systems.

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The grand total of salaried officials, clerks, etc., was 29,470, of whom 25,298 were employed by the telephone systems and 4,172 by the commercial telegraph. The telephone officials, etc., received in salaries £4,020,505, and the telegraph clerks £582,278. The total of 142,733 wage-earners is divided, 118,871 belonging to the telephone systems and receiving in wages £10,204,313, while the 23,862 telegraph wage-earners were paid £3,127,815.

The grand total income was £49,176,170, of which the telephone concerns earned £38,429,331, expending £29,333,813, and the telegraph system earned £10,746,639, expending £8,724,920. Of the whole number of systems in operation, the telephone formed 99·9 per cent.

The surprising thing about this report is the rapid growth of the the telephone business, which is still far from the height of its possibilities.

TELEPHONE POLES ON HIGHWAYS AND LOCAL AUTHORITIES.

It is interesting to witness the differences which so commonly arise between the Post Office and Local Authorities when the former seeks the consent of the latter for the fixing of telephone poles on public highways. The objection which is raised by Councils on æsthetic grounds that telephone poles are unsightly is often diverting in the extreme, more especially when it happens to come from Rural District Councillors, whose eye for the picturesque in Nature is so wonderful. The objections raised against telephone poles and telephone wires—which are as indispensable as railway trains and motors—are, in the main, as sentimental and reasonable as those which were raised against the latter on their first introduction. District Councils say that they prefer the wires placed underground—a system which costs about ten times more than the overhead system. The public who use telephones complain of the heavy annual rentals charged for their use, and that they are higher than in other countries. But in other countries the Postal Telegraph Departments are not hampered by æsthetic-minded District Councillors, and can construct their trunk and branch lines cheaply. The English public cannot both have their cake and eat it, and, if a little more sapience were shown by District Councils and the public, there is a chance that the charge for telephones—which are so essential to all firms and persons who are not disposed to become moth-eaten—will become cheaper.

The Engineers of the Postal Telegraphs.—It cannot be said that the Post Office Department are disposed to treat Local Authorities unfairly nor to act in an unreasonable manner. The Engineers of the Postal Telegraphs Department have earned, and deservedly so, the reputation of being as tactful and courteous a body of men as can be found in any class of public officials, and endeavour to conform to all the reasonable requirements of Local Authorities and their Engineers and Surveyors.—'Sanitary Record.'

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SIR HENRY BABINGTON SMITH, K.C.B., C.S.I.

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NOTES AND COMMENTS.

The Retiring Secretary.

Sir Henry Babington Smith, who at the end of the present year will forsake the Secretaryship to the Post Office for the directorship of the Turkish Bank, has occupied his present post since 1903. Son of the late Archibald Smith, F.R.S., of Jordanhill, Renfrewshire, he was educated at Eton and Trinity College, Cambridge, of which he became a Fellow; first class in Classical Tripos (Parts I and II), and Chancellor's Medallist (M.A.).

Entering the Civil Service he became an examiner in the Education Department, 1887; principal private secretary to the Chancellor of the Exchequer (Mr. Goschen), 1891; clerk in the Treasury, 1892; secretary to the British delegates at the Brussels Monetary Conference, 1892; private secretary to Earl of Elgin, Viceroy of India, 1894–1899; financial mission to Government of Natal, 1899; British representative on Council of Administration of Ottoman Public Debt, 1900, and President, 1901, which post he retained until his appointment to the Post Office. He was decorated C.S.I. in 1897, for services as private secretary to the Viceroy, and first class Osmanieh in 1903. It will be observed that in proceeding to Constantinople Sir Henry returns to scenes with which he is already familiar.

So far as the Engineering Department is concerned, the principal events of his administration have been the development of the London Telephone Service and the negotiations with the National Telephone Company, which led to the 1905 Purchase Agreement. There can be no doubt that this agreement solved an exceedingly difficult problem, and by averting ruinous competition effected a national economy of considerable magnitude.

Later, his able chairmanship of the International Wireless Conference still further heightened his reputation.

To his other attainments Sir Henry adds the accomplishment of being a polished orator, and on this account no less than for his genial manner he has been annually a welcome guest at the Engineering Department dinners.

He leaves many friends in the Post Office, whose good wishes for a prosperous future will go with him to the Orient.

The New Secretary.

Lieut.-Col. Sir Matthew Nathan, G.C.M.G., R.E., will take up next January the duties relinquished by Sir H. Babington Smith.

Born in 1862, he is one of a remarkable quartette of brothers,

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sons of a city merchant, Mr. Jonathan Nathan, all of whom have gained distinction in the public service, for which services three of them have already been knighted. His early education was obtained from private tutors and at the Royal Military Academy, Woolwich, and in 1880 he joined the Sappers and gained distinctions in the Nile (1885) and Lushai (medal and clasp, 1889) campaigns.

From 1895 to 1899 he was engaged as secretary to the Colonial Defence Committee in London. In 1898 he was gazetted as Major.

In the following year he was sent to Africa to administer the Government of Sierra Leone, and in the same year gained the C.M.G.

His experience as a Colonial Governor was continued in 1900, when he succeeded Sir F. M. Hodgson as Governor of the Gold Coast.

At this point in his career he attained to the dignity of knighthood, and in 1903 he was removed from Africa to Asia, becoming Governor for Hong Kong, which position he occupied with such success that in two years he was returned to the African dominions to occupy the exalted position of Governor of Natal.

At the age of forty-seven Sir Matthew is still a bachelor. He is credited with great administrative ability and with conspicuous judgment and tact.

In taking over the reins of office when the Post Office is preparing for another gigantic addition to its responsibilities, he will have a difficult *rôle* to fill, and all our readers will join in hoping that the good fortune which has attended his career up to the present point will still remain in attendance.

THE appointment of Lieut.-Col. Sir Matthew Nathan, G.C.M.G., R.E., to the Secretaryship to the Post Office adds yet one more to the list of cases in which individuals trained as engineers have attained to the supreme command of great organisations, and from this point of view the advent of the new secretary will be of special interest to the Engineering Department. We do not here need to enlarge on the practical value of such training—our readers are well aware of it—and it is almost trite to say that, given equal organising ability, the man who has been technically trained, who has been accustomed to conceive ideas and see them carried into actual being, has an advantage of much weight in the successful conduct of a great business as compared with the man whose training has missed this essential feature.

While the trend to which we refer has been specially noticeable in connection with municipalities and the public services, we will content ourselves with quoting two noteworthy examples.

The President of the Institution of Mechanical Engineers, Mr. John A. F. Aspinall, M.Inst.C.E., is the General Manager of the Lancashire and Yorkshire Railway.

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The President of the Institution of Civil Engineers, Mr. James Charles Inglis, is the General Manager and Consulting Engineer of the Great Western Railway Company and of Fishguard Harbour. After occupying the post of Chief Engineer to the Company from 1892, Mr. Inglis was given the supreme control in 1903. It is common knowledge that his successful administration has been recently distinguished by the diversion of the New York–London Cunard passenger route from Liverpool to Fishguard, and the realisation of this long-contemplated idea must be regarded as almost a personal triumph for the great Engineer-Manager.

Retirement of Mr. John Jenkin, M.I.E.E.

Entering the service of the P.O. from the Electric Telegraph Company at the transfer in 1870, Mr. Jenkin soon became an Engineering Superintendent, and acted as Assistant to Mr. Shaw, then Divisional Engineer, remaining in that position until the reorganisation in 1878. During the illness and subsequent to the death of Mr. Shaw in 1876, Mr. Jenkin was in actual charge of the latter's Division until the re-organisation, when the Divisional Engineers were abolished and Superintending Engineers created. On Mr. Edward Graves becoming Engineer-in-Chief he gave Mr. Jenkin the Relief Superintending Engineership, which was to have been filled by Mr. Sivewright, who was at that time loaned to the Cape Government to organise its telegraphs, and was invited to remain there, becoming in time Cabinet Minister and Sir James Sivewright, C.M.G.

Mr. Jenkin subsequently settled down in permanent charge of the Eastern District. He was then the youngest by many years of the original officers of that rank, and it is his lot to be the last of them to leave the Service.

His early days at Cambridge were uneventful, but the preparations for the reduced tariff on telegrams brought out that restless activity which has been characteristic of him up to his retirement. Amongst the many new lines then to be erected was one through the picturesque district from London *via* Barnet, Potters Bar, Hatfield, Welwyn, and Stevenage to Peterboro. The various public bodies refused their permission for open lines, public indignation meetings were held, to the great advantage of the local press, Mr. Jenkin was burnt in effigy at Stevenage and became the subject of verse in the poet's corner of the newspapers. His strength of character, his tact and sound judgment, his affability under provocation, and his

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dignified firmness wore down all opposition; and when at last the consents were given he had the satisfaction of knowing that he left as friends those who had been the most strenuous opponents. Officers who were associated with him at the time will not forget his keen enjoyment of these fights.

Of dignified presence and irreproachable address, Mr. Jenkin has been an ideal representative of the Department in all negotiations with the public, and has the advantage of being a clear and ready speaker, listened to with patience and respect. The writer has many times heard him state before public bodies requirements of the Department to which objection has been raised, but can recall only one interruption. "What!" exclaimed a surveyor, indignantly, "Erect black poles against the cemetery gates?" "Surely," replied Mr. Jenkin, "black is the very best colour for proximity to a cemetery?" The council, with whom the surveyor was not popular, laughed, and black poles were erected.

Mr. Jenkin has always taken the greatest interest in the welfare of his staff, and is believed to have missed no opportunity of promoting their interests; but he has also always required of them a high standard of work, and would suffer no slovenliness. No matter how short of staff the office might be, the character of the work done had to be maintained at the same high level. His influence and example in this connection have been an education to many of his subordinates now holding responsible positions in the Department, for which they will long be grateful.

Mr. Jenkin was elected an Associate of the original Society of Telegraph Engineers in 1872, and became a member in 1877.

He retires full of vigour, a loyal servant, proud to the last of the Department he represented. E. T. T.

Retirement of Mr. W. W. Vyle.

Mr. W. W. Vyle recently retired from the service under the age-limit. Prior to his promotion to the position of Superintending Engineer of the South Wales District, Mr. Vyle had great, and, in some senses, exceptional experience in the North-Western District at Manchester. Entering the Engineering Department in 1872, he served for twenty-six years under the late Mr. John Doherty, and altogether spent twenty-eight years in Manchester before removing to Cardiff. During that time two fires occurred at the Telegraph Office in the former city, one in the old York Street building, and the other at the

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present Post Office in Spring Gardens in September, 1900. The latter was disastrous, a portion of the building being gutted. Mr. Vyle took in hand the immediate restoration of communication, and circuits were improvised in the corridors while the fire was still burning. In April, 1901, Mr. Vyle went to Cardiff and entered upon the extension of the Post Office Telephone Exchange system in direct competition with the National Telephone Company.

The development since that date has been extensive, practically every town and village in the thickly populated parts of Glamorgan and Monmouth having either an exchange or a call office.

Mr. Vyle served under five Engineers-in-Chief, viz. Mr. Graves, Sir Wm. Preece, Mr. Hookey, Sir John Gavey, and Major O'Meara.

His retirement was a matter of sincere regret to the staff over which he had control, for their appreciation of Mr. Vyle, as a chief who had on all occasions displayed exceptionally fine qualities of mind and heart, was deep and sincere.

The staff regret him as a considerate and popular chief, whose uniform kindness and clear judgment, coupled with his unvarying gentlemanliness, made him respected by all. For him everyone, from the lowest to the highest, tried to do his best.

Representatives of every grade of the staff regret Mr. Vyle's cessation of active service, and tender him sincere good wishes for his future welfare.

Outside the service Mr. Vyle is well known and highly respected. It is the wish of all that he may live many years to enjoy the days of leisure lying before him.

The Loading of Telephone Circuits.

It is now well established that the speech transmission efficiency of the circuits in any type of underground or submarine telephone cable in common use may be increased 3 to 3·5 times by the proper insertion of loading or inductance coils; but it must not be gathered from this fact that loaded underground circuits are equal to overhead unloaded ones for long distance telephone purposes. For the reason that the expense involved is out of all proportion to the transmission efficiency obtained, it is not usual to lay underground telephone loops exceeding 200 lb. per mile of conductor in weight; these, even when loaded, are greatly inferior to overhead circuits of the same gauge.

The conditions in this country are such that in long land telephone lines some underground sections can scarcely be avoided, while between England, Scotland or Wales and Ireland or the Continent a submarine cable is necessary. In these circumstances the ability to improve the transmission efficiency of the underground

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or submarine sections three times by loading is a matter of considerable interest to the engineer in his efforts to meet public demands. At the present time the following points, summarised from Mr. A. W. Martin's paper on "The Loading of Telephone Cable Circuits," delivered before the Institution of Post Office Electrical Engineers in January and February, 1909, may be of practical interest.

Mr. Oliver Heaviside shows (see 'Electrical Papers,' vol. ii, p. 400) that the attenuation constant—say β—of any telephone circuit is:

$$\beta = \sqrt{\tfrac{1}{2}\left[\sqrt{(R^2+p^2L^2)\,(S^2+p^2K^2)} + (RS-p^2LK)\right]}$$

where—

R = effective resistance in ohms per mile of loop,
L = effective inductance in henrys per mile of loop,
K = electrostatic capacity in farads per mile wire to wire,
S = leakance in mhos. per mile,
p = 2π times the periodicity per second.

In any good underground or submarine cable loaded loop, pL is great compared with R, and pK great in comparison with S. This being so the above lengthy expression may be reduced to—

$$\beta = \frac{R + \frac{S}{K}L}{2}\sqrt{\frac{K}{L}}$$

The only difficulty in applying this formula in practice is the uncertainty of the value of $\frac{S}{K}$. There is, for instance, very little reliable information as to the value of S, the leakance, at different periodicities of applied E.M.F. A practical way out of the difficulty has been found by measuring the transmission efficiencies of a number of loaded circuits in terms of standard cable. Now, standard cable in this country is that having a resistance of 88 ohms and electrostatic capacity of 0·054 microfarads per mile of loop respectively, with an insulation resistance wire to wire of not less than 200 megohms per mile. The attenuation constant of such cable is 0·103 per mile at a periodicity of 750 per second. If the standard cable equivalent of a circuit be determined by experiment, its attenuation constant is easily found by dividing 0·103 by the number of times which the circuit is better than standard cable.

From a large number of experiments it is certain that if $\frac{S}{K}$ be taken as 80, the calculated and observed results will agree very closely in the case of either air-space paper insulated or gutta-percha-covered telephone loops loaded with iron core coils (where the word "iron" covers steel and magnetic alloys). It is, indeed,

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found that the attenuation constant of any such loaded circuit may be forecast with all necessary accuracy in practice from the equation—

$$\beta = \frac{R + 80L}{2} \sqrt{\frac{K}{L}} \quad . \quad . \quad . \quad (1)$$

But it must not be forgotten that R is the effective resistance per mile of loop at 750 periods per second, including conductors and coils. K may be taken as the electrostatic capacity per mile of loop measured by the simple charge or discharge method, and L as the inductance per mile added by the insertion of the coils; the inductance of the loop itself being of the order of 1 millihenry per mile and therefore negligible.

In addition to being able to foretell with some precision what the attenuation in a circuit will be, it is necessary to know how far apart the coils to be used must be placed in order to obtain the desired attenuation, and at the same time ensure good articulation. Starting with the facts that (1) there must be at least π coils per wave length, and (2) wave length $= \frac{2\pi}{a}$, where a is the velocity constant equalling $p\sqrt{KL}$; further, assuming the highest essential frequency to be 2000 periods per second it is not difficult to show that if—

d = distance apart of coils in miles,

k = electrostatic capacity wire to wire per mile in microfarads,

l = inductance in millihenrys *per coil*,

then $d\,k\,l = 25{\cdot}3$ is a maximum permissible value. But to ensure that there shall be rather more than two coils per wave for the highest assumed essential frequency, it is usual to take—

$$d\,k\,l = 20 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

So far as present knowledge and experience show it is necessary to put coils in a circuit such that the expressions (1) and (2) are satisfied, bearing in mind that the latter may lie anywhere between $d\,k\,l = 20$ and 25.

A point worthy of particular notice is that the coils should be inserted in any circuit at intervals regular to within 5 per cent., otherwise, and as experiment shows, there will be appreciable loss of efficiency due to reflections in the cable. It is also desirable that the spacing of the coils should be such that the first and last coils are half the normal spacing distance from the terminal stations.

The Latest Electrophone Achievement.

To many it may seem somewhat superfluous to add anything to what has already been written in the 'Evening News' and 'Daily Mail' regarding the electrophoning of Lord Rosebery's speech from Glasgow to London; we can, however, add one or two items.

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Some 2000 miles of wire were utilised, and of this quantity over 1600 were the property of the Department.

The trunks selected were Glasgow 1 and 3, of 600 lb. and 300 lb. per mile respectively, standard cable equivalents 14·60 and 22·06.

Each of these trunks follows the Midland Railway route *via* Luton, Nottingham, and Carlisle. Underground wires were used from Glasgow Post Office to the City Hall, and at the London end from Finchley to the Trunk Exchange, Carter Lane, and thence *via* two junctions to the National Telephone Company's Holborn Exchange, from which point they were extended to the newspaper offices.

At the London Trunk Exchange two pairs of pegs with specially long cords were prepared, and the connections effected direct between panels 2 and 6 of the test board, all apparatus being thus cut out of circuit and the trunks put straight through to the Company's exchange. The apparatus was also cut out at Glasgow Post Office.

It was arranged that should any difficulty be experienced the National Telephone Company's representative would immediately telephone to the Trunk Exchange manager; otherwise the lines would on no account be disturbed.

Lord Rosebery spoke for two hours, from two till four, and nothing was heard from the National Telephone Company's representative till after the latter hour, when he telephoned that the Trunk arrangements had been highly satisfactory, and that the trial had proved an unqualified success, nothing having occurred to mar the sequence of the speech.

The average interval of time between an utterance at Glasgow and its record by the reporters in London was four seconds only. Nearly six columns of the speech were on sale in the London streets before four o'clock while Lord Rosebery was still speaking—a fact said to be unprecedented in the annals of journalism, telegraphy, or telephony. The transmitters in use at Glasgow were of the Italian type invented by Giuseppe Angelini. At the London end double hand receivers as used for electrophone service were employed.

The transference of the reporter from the auditorium to the *editorium*, if we may coin a word, and the complete elimination of the hitherto indispensable telegraph is a very interesting development, but one which the telegraphist must regard with at least some degree of apprehension.

"Wireless" Calls for Help.

The means suggested for determining the location, by means of "wireless" signals, of a vessel at sea in the translation from the German of an article by Mr. Bela Gati, on another page, whilst correct in principle is perhaps open to criticism from the practical

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point of view. The use of any form of mirror galvanometer in a heavy seaway is not consistent with reliability of measurement. Further, as wireless transmitters in practical use at present are far from exhibiting constancy of operation, it is more than possible that such measurements, if made, would give very erroneous results. It may not be sufficiently known, however, that there is another and much handier method of gaining the approximate bearing of a vessel from the signals sent out, and which has the advantage of being practised daily by wireless operators who have to manipulate modern tuned receivers provided with variable coupling. The method simply consists in reducing the coupling of the receiver until the signals are at vanishing point and noting the angle of the coupling coils. By taking three or more such readings at different times it can be easily determined how the distance from the transmitter is changing. In fact the operators are usually, if not invariably, in possession of a table giving the necessary constants for obtaining the approximate distance of the usual type of transmitter, even from a single reading. Moreover, this method of gauging distances is of great utility in arranging the order of transmission when two or more vessels desire to communicate with the same station. In practice also, a vessel in distress will usually signal her bearings to all who may be within range of the wireless transmitter. J. E. T.

Sub-Engineers' Examination.

In connection with the list of names of officers who succeeded in passing the above examination given in our last issue, we desire to add that Messrs. E. A. Lakey and G. C. Mason (relay clerks) also qualified.

Major W. A. J. O'Meara, C.M.G., R.E., Engineer-in-Chief to the Post Office, and Mr. G. F. Preston, General Manager London Telephone Service, sailed for the United States on the 10th September. They will make a three months' tour of the principal telephone centres with a view to acquiring information on recent developments.

The Visit of H.M. King Edward and the Czar and Czarina to Cowes.

The telegraph and telephone engineering arrangements in connection with the Cowes Regatta on the occasion of the Naval Review by His Majesty the King, and the visit of their Imperial Majesties the Emperor and Empress of Russia, were somewhat unusual and interesting. Over 400,000 words of press messages were dealt with, and the number of ordinary telegrams was very large.

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Two Wheatstone duplex circuits were provided from Cowes Post Office to London, and one Wheatstone duplex circuit from Cowes Post Office to Southampton, extended to London at 6 p.m. each evening.

A four-core cable was laid between the Cowes Post Office and the Royal yacht "Alexandra," and two cores of this cable were extended to the National Telephone Company's Exchange, a magneto set being fitted on the yacht.

A seven-core cable was laid between the Cowes Post Office and H.M. the King's yacht "Victoria and Albert" to provide circuits as under:

One D.C. sounder circuit to T.S.;

One D.C. sounder circuit to Cowes;

One D.C. sounder circuit to H.I.M. yacht "Standart";

One telephone circuit to the Cowes National Telephone Company's Exchange; and

One telephone circuit to Barton Manor Stables, Osborne. The latter circuit involved the erection of 1000 yards of aërial cable between Osborne Exchange and the Stables.

A four-core cable was laid between the Cowes Post Office and H.I.M. yacht "Standart," one core being used for a D.C. sounder circuit to H.M. yacht "Victoria and Albert," the "Victoria and Albert" transmitting the Russian work to London.

Two cores were utilised for a telephone circuit to the National Telephone Company's Exchange and one core left spare. The three yachts had thus intercommunication *viâ* the Exchange.

A special cable was laid from Lee-on-Solent Post Office to H.M.S. "Cyclops," and D.C. sounder duplex apparatus fitted on the ship. Messages were sent from the fleet by wireless to the "Cyclops" and transmitted direct to Portsmouth. An emergency set was fitted at Lee-on-Solent in case of breakdown of the cable.

A telephone circuit was also provided from H.M.S. "Essex."

The apparatus for the Russian yacht, with an officer for joining up, was put on board with the navigating party below Portsmouth, and everything was ready for joining through immediately the yacht came to the mooring at Cowes.

H.I.M. the Czar evinced his satisfaction by conferring the Russian order of St. Sophia upon the engineer, Mr. J. S. Brown, and presenting a gold watch and chain to the lineman.

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INSTITUTION NOTES.

COUNCIL NOTES.

THE eighteenth meeting of the Council of the Institution of Post Office Electrical Engineers was held at Liverpool on July 21st and 22nd. Mr. A. J. Stubbs presided, and there were also present—Messrs. H. Hartnell, A. W. Martin, G. Stannage, E. T. Titterington, J. W. Atkinson, W. Scott, T. Smerdon, J. Wyatt, C. H. Barrett, and J. T. Williams, Members of Council; Mr. H. R. Kempe, Hon. Treasurer, and Mr. J. M. Crawford, Secretary.

LOCAL SECRETARYSHIPS.

A majority of the local centres have voted in favour of the principle of making the office of local secretary an elective one, and the Council have agreed to amend the rules so as to give local centres the option of throwing open the position to popular election, or of retaining the existing arrangement by which the secretary is appointed by the local centre committee itself.

LOCAL LIBRARIANS.

A new office has been created in the form of a local librarian, with the object of relieving the local secretary of a certain amount of routine work in connection with the distribution of library books and technical periodicals.

CLERICAL STAFF.

The Council have invited local centres to consider the best means by which the Institution can be rendered more attractive to members of the clerical staff, as it is generally acknowledged that the claims of the clerical force demand special consideration. Several suggestions have been made on the subject, chief among these being the addition to the Central Library of works on book-keeping, commercial law, etc., also the circulation to members of the clerical force of periodicals on kindred subjects; whilst it has been proposed that the inclusion of papers of special interest to the clerical staff in the local centre programme of meetings would effect an improvement. The matter is engaging the earnest attention of the Council, and it is hoped that, with the hearty co-operation of the local centres, a solution of the difficulty may be found.

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Assistance to Members in the Preparation for Examinations.

The Committee of the Council appointed for this purpose reports that fair progress has been made with the compilation of the notes and data authorised for publication, but that, owing to exceptional pressure, it has not been possible to prepare a report for presentation to the Council. The Committee anticipate completing their labours and to be in a position to present their report at the next meeting of Council.

Membership.

The following statement of membership to date was submitted by the Secretary, viz.:

Number on Roll, March 31st, 1909		828
By deaths, retirements, and resignations		64
		764
New members:		
Home	10	
Colonial	5	
Foreign	1	
	—	16
Total		780

Finance.

The Council dealt at great length with the financial position of the Institution in view of the decreasing balance, and the immediate necessity for drawing upon the deposit account to meet liabilities already incurred.

In this connection, the question of reducing the number of technical periodicals in circulation is engaging attention, as it is felt that the present supply is in excess of requirements. This phase of the subject is being dealt with by the Library Committee, who have asked members to vote for a reduced number of periodicals.

The relative advantages of reducing expenditure on technical periodicals, or of even abandoning their supply altogether, as against a reduction in the number of printed papers, was considered, but the Council postponed action until the next meeting.

Printed Papers.

The abstract of Mr. G. H. Comport's paper on "Underground Telegraphs" has been issued to members.

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The Council have voted in favour of printing the following papers, viz.:

"The Education of a Post Office Electrical Engineer," Mr. A. W. Heaviside.

"The Development and Theory of C.B. Telegraph Systems," Mr. J. Fraser.

"Repeaters," Mr. H. Kitchen.

"Knots and Splicing in their Relation to Telegraph Construction," Mr. F. C. Horner.

In view, however, of the present financial position the papers already voted for printing, but not yet sent to the press, have been held back for re-consideration.

In order that the Council may be in a better position to definitely decide as to the publication of the papers referred to, competitive tenders for printing are being obtained, and the further consideration of the matter deferred until next meeting.

Transfer of Irish and Southern District Members.

The arrangements for the formation of a new centre for the South-Western District are not yet completed.

With respect to the members transferred to the South-Eastern District, arrangements have been made for members to attend meetings of the Metropolitan Centre.

Steps have been taken with a view to the preparation of a programme of meetings for the Ireland Centre.

Free Postage of Technical Periodicals.

The Council have considered the necessity for making some special provision for the transmission of technical periodicals when these are sent through the post, and it has been agreed to issue special wrappers for the purpose.

As far as possible the official correspondence covers will be utilised, but where these are not available, the wrappers, franked before dispatch with the usual office frank, will be brought into use.

Departmental Grant for Technical Education.

In connection with the annual grant of £50 made by the Treasury to the Engineer-in-Chief for payment of fees for special educational courses, the Chairman announced that the Engineer-in-Chief had been good enough to invite suggestions from the Council for the expenditure of £20 of the total sum, particularly in the direction of payment of lecturers for addresses delivered under the auspices of the

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Institution, the only stipulation being that the lecturers and subjects should have the approval of the Engineer-in-Chief. The Council expressed their keen appreciation of this offer, and arrangements are being made with the object of securing the fullest possible benefit from the proposition.

COUNCIL MEETINGS.

IT has been decided to hold future meetings at the headquarters of the different Local Centres in turn, and the next Council Meeting will be held at Manchester on October 5th and 6th, 1909. Edinburgh will be visited on December 7th next, and Glasgow on December 8th.

It is hoped that the Local Centres concerned will be able to arrange Institution meetings on these dates, in order that members may be brought into closer touch with the governing body.

LOCAL CENTRE NOTES.

NORTHERN CENTRE.

THE prospects for the 1909–10 Winter Session, so far as the Northern Centre is concerned, are very good indeed.

A full programme of six meetings has been arranged, as follows:

October 11th, 1909.—Inaugural Address. Mr. J. McL. Robb.

November 8th, 1909.—"Ropes and Knots as Applied to Telegraph Engineering." Mr. C. Whillis.

December 13th, 1909.—"Graphical Methods of Calculating Mixed Circuits." Mr. A. G. Lee, B.Sc.

January 12th, 1910.—"Morning Testing." Mr. H. Kitchen.

February 14th, 1910.—"Gas and Petrol Engines." Mr. J. W. Ray.

March 14th, 1910.—"Fault Systems." Mr. A. McLaughlin.

METROPOLITAN CENTRE.

VISIT TO CABLE SHIP "MONARCH."

At the invitation of Mr. W. R. Culley, I.S.O., Submarine Superintendent, the members of the Metropolitan Centre opened the programme of the new session in a very agreeable fashion by paying a visit to the Submarine Depôt and Cable Ship "Monarch," at Woolwich on the 1st September, 1909.

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The visitors were met at the Cable Depôt by Mr. Culley, who took charge of one half of the party, while the other half was placed under the direction of Mr. Ramsay. The design of the Stores Depôt and the excellent arrangement of the stores appealed to the visitors at once. It was noted that many articles, not hitherto associated in the visitors' minds with engineering stores, had been brought under the sway of the tally card, such as cruets, glasses, cutlery, brass-banded casks for salt beef, articles for bed-room use, and such like. In the Cable Shed submarine cables were seen under repair, and some actual splices were carried out for the visitors' instruction. The most interesting room, however, was that of Mr. Culley, where he showed specimens of cable recovered at various times during his long service, and gave interesting particulars regarding the life and history of each of the specimens, most of which were covered with barnacles and other deep-sea growth. Specimen faults, due to the *teredo* worm and to other causes, were also shown and explained.

The visitors were taken over to the "Monarch" in boats, and Mr. Wrake, Chief Navigation Officer, assisted in conducting them over the ship. Every part of the "Monarch," including stoke-hole, engine room, cable tanks, picking-up and paying-out machinery, etc. was fully explained, no effort being spared to make all the details quite plain. The method of adjusting the "compass error" and taking soundings were minutely described, and the test-room—in which the cable is kept under electrical test whilst being laid—proved very interesting.

The clean and tidy appearance of the ship, and the comfortable accommodation provided for the officers and men, seemed to appeal to the landlubber's eye.

The visitors were entertained to tea in the saloon of the "Monarch," and before leaving the cable ship, Mr. Moir—the Chairman of the Metropolitan Centre—proposed a hearty vote of thanks to Mr. Culley and his assistants for the trouble they had taken in preparing the plant and tackle so that it might be seen to best advantage; for the courtesy and patience they had shown in explaining the different processes and answering the volleys of questions which had been addressed to them; and above all, for the extra-official hospitality which they had shown in the tea saloon. Mr. Culley expressed the pleasure which the visit of the members had afforded him and the other members of his staff. They were always glad to make new friends, and he hoped to have the pleasure of seeing other members of the Institute on some future occasion.

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METROPOLITAN CENTRE. SESSION 1909-1910.

MEMBERS will be interested to learn that the Committee have been successful in obtaining Mr. H. R. Kempe to open the Session on October 13th with a paper on "Pneumatics." It has not been possible to definitely arrange the order in which the papers will be given, but in addition to Mr. Kempe the following gentlemen have promised to give papers on the under-mentioned subjects during the Session.

Mr. H. Hartnell .	. Submarine Cables.
Mr. A. C. Booth .	. Radio-Telegraphy.
Mr. J. Sinnott .	. Fire Alarm Systems.
Mr. J. W. Atkinson	. Estimates and Records.
Mr. R. Waring .	. Telephone Development Studies.

It has also been arranged for the Lectures to be given in the Lecture Hall of the Northampton Institute.

CHESS NOTES.

THE opening night of the G.P.O. Engineering Department Chess Club has been fixed for Tuesday, October 5th, when play will commence at 6 p.m. The headquarters are "Ye Mecca," 140, Cheapside, E.C., and the Club meets once a week. Membership is open to all clerical and engineering officers in the Engineer-in-Chief's office and in the Metropolitan Superintending Engineer's districts. Officers desirous of becoming members are invited to communicate with the hon. secretary, W. H. Stephenson, Engineer-in-Chief's office, who will be glad to furnish information in regard to the Club. The annual subscription is 3*s*.

W. H. S.

LAWN TENNIS MATCHES.

ENGINEER-IN-CHIEF'S OFFICE *v.* METROPOLITAN SOUTH ENGINEERING DISTRICT.

A RETURN match was played at Southfields on the 1st July and resulted in a win for the Engineer-in-Chief's Office by 4 events to 2, 10 sets to 5, and 74 games to 56.

H. W. Fulcher and E. H. Walters beat A. Warren and J. E. T. F. Hilton 6—5, 4—6, 6—1; beat T. L. Robinson and W. G. Restall 6—1, 6—3; beat A. T. Restall and R. Purves 6—2, 6—0.

D. H. Kennedy and A. E. Thorne lost to A. Warren and J. E. T. F. Hilton 1—6, 6—3, 2—6; lost to T. L. Robinson and W. G. Restall 6—5, 4—6, 3—6; beat A. T. Restall and R. Purves 6—4, 6—2.

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STORES DEPARTMENT *v.* ENGINEERING DEPARTMENT.

THE annual match was arranged to be played on the 24th August at Wandsworth Common, but unfortunately had to be abandoned, a short time after play had commenced, owing to rain. The teams were:

Stores Department.—T. B. Barker, G. H. McGregor, H. J. S. Bennett, P. Green, and F. L. Hawkins.

Engineering Department.—H. W. Fulcher, E. H. Walters, A. Warren J. E T. F. Hilton, A. E. Thorne, and J. H. Howell.

LIBRARY NOTES.

The following books have recently been added to the Library, and are available for the use of members:

No.

163. 'Industrial Electrical Measuring Instruments.' K. Edgcumbe.
164. 'Electricity in Factories and Workshops.' A. P. Haslam.
165. 'Heavy Electrical Engineering.' H. M. Hobart.
166. 'Theory and Practice of Electric Wiring.' W. Ibbetson.
167. 'Transformers for Single and Multiple Currents.' E. Kapp.
168. 'The Principles of Alternating Currents.' E. G. Larner.
169. 'Theory of Electric Cables and Networks.' A. Russell.
391. 'Strength of Materials.' A. Morley.
392. 'Alternating Current Phenomena.' C. P. Steinmetz.
393. 'Strength and Elasticity of Structural Members.' R. T. Wood.
394. 'General Lectures on Electrical Engineering.' C. P. Steinmetz.
457. 'An Introduction to the Science of Radio-Activity.' C. W. Raffety.
520. 'Vectors and Vector Diagrams Applied to the Alternating Current Circuit.' W. Cramp and C. F. Smith.
693. 'Theory and Practice of Bridge Construction.' M. W. Davies.
731. 'Greenwich Magnetical and Meteorological Observations,' 1901.
732. Ditto, 1902.
733. Ditto, 1905.

The following books are offered for sale. Offers for the purchase of same should be sent to The Librarian, Room 11A, G.P.O. West.

'Engineers' Year-Book of Engineering Formulæ, Tables, etc.' H. R. Kempe, 1905 and 1906.

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'Handbook of Electrical Testing.' H. R. Kempe, 1900.
'Electrical Engineering.' W. Slingo and A. Brooker, 1903.
'Pocket-Book of Electrical Rules and Tables.' Munro and Jamieson, 1904.
'Secondary Batteries.' E. J. Wade, 1902.
'Lectures on Sound.' J. Tyndall, 1902.

BOOKS RECEIVED.

'La Telephonie,' 3e edition. Tome I: Les Lignes téléphoniques, par Emile Picard, Ingénieur en chef, Directeur de service à l'administration des Telegraphes Belges, Professeur d'électricité à l'Université libre de Bruxelles. Octavo, 254 pages, with 173 figures. 7 fr. 50. Ramlot, 25 rue Gretry, Bruxelles (H. Dunod et E. Pinat, éditeurs, 49, quai des Grands-Augustins, Paris 6e).

In addition to essential information on aerial lines, M. Picard gives curves showing the variation of stress with different lengths of span. These are the result of arduous labours involving the resolution of equations of the third degree, and have cost the author many hours of labour. Exhaustive descriptions of underground and aerial cable work are also given. The last chapter, giving the theory of Pupin relating to the propagation of telephonic waves on long lines, is very clear and precise, and terminates by various examples of the application of the formulæ to lines.

The book is original, well illustrated, and well printed. It is a pity one cannot add well bound, as only the usual paper back of the continent has been provided.

'Examination Questions in Electrical Engineering.' Rentell & Co., Ltd. 1s. net.

This little book, which has been compiled by a certificated teacher, contains the questions set in the Elementary Grade by the City and Guilds Institute during the past nine years. Answers are given to the numerical questions, and full solutions to the paper for 1908. The book not only provides the student with material for testing his knowledge of the subject, but indicates the extent of the field which his studies should cover; and although the book, in the matter of printing, is occasionally at fault where exponents are concerned, *e.g.* the formulæ at the foot of page 52 and top of page 53, where 10^6 is involved, it is on the whole neatly got up, and will doubtless be of much assistance to those preparing for the Elementary Examination.

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STAFF CHANGES.

BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

APPOINTMENT.

District.	Name.	Appointment.	Previous Service.
E. in C.O.	Gunton, H. C.	Principal Power Engr.	—

PROMOTIONS.

N.	Robb, J. McL.	Suptg. Engr.	Tel., Belfast, 1874; Jr. Clk., Engr. Dept., 1882; Insp., 1887; Engr., 1st Cl., 1897; Asst. Suptg. Engr., 1902; Staff Engr., 1st Cl., 1907.
E.	Lamb, J. F.	Suptg. Engr.	Tech. Offr., 2nd Cl., 1898; Asst. Suptg. Engr., 1903; Staff Engr., 1st Cl., 1907.
E. in C.O.	Taylor, J. E.	Staff Engr., 1st Cl.	Tel., C.T.O., 1888; Sub-Engr., 1892; Engr., 2nd Cl., 1896; Tech. Offr., 2nd Cl., 1899; Asst. Suptg. Engr., 1905.
Ire. N.	Masaroon, R. G.	Asst. Suptg. Engr.	S.C.&T., Londonderry, 1882; Royal Engr., 1883; Engr., 1st Cl., 1904.
Met. S.	Stanhope, J. H.	Asst. Suptg. Engr.	Tel., Leeds, 1881; Sub. Engr., 1896; Eng., 2nd Cl., 1898; 1st Cl., 1901.
N.M.	Twells, W. E.	Engr., 1st Cl.	Tel., Derby, 1892; Jr. Clk., 1896; Engr., 2nd Cl., 1901.
S.W.	Brown, J. S.	Engr., 1st Cl.	Tel., Leeds, 1882; Jr. Clk., 1895; Sub. Engr. 1898; Engr. 2nd Cl., 1901.
Met. C.	Wilson, R.	Engr., 1st Cl.	Tel., Grimsby, 1887; Jr. Clk., 1895; Sub. Engr. 1898; Engr. 2nd Cl., 1901.
N.M.	McMorrough, F.	Engr., 1st Cl.	S.C. & T., Sheerness, 1884; Tel., Liverpool, 1889; Jr. Clk., 1906; Sub. Engr. 1899; Engr., 2nd Cl., 1901.
S. M.	Giffen, A. E.	Engr., 1st Cl.	S.C. & T. Glasgow, 1886; Jr. Clk., 1896; Sub. Engr., 1900; Engr., 2nd Cl., 1902.
N. Wa.	Kemp, H.	Engr., 1st Cl.	S.C. & T. Manchester, 1887; Jr. Clk., 1896; Sub. Engr., 1899; Engr., 2nd Cl., 1902.
N.	Whillis, C.	Engr., 1st Cl.	S.C. & T. Newc.-on-Tyne, 1889; Jr. Clk., 1897; Sub. Engr. 1899; Engr., 2nd Cl., 1902.
E. in C.O.	Boddington, M. F. G.	Clk., 1st Cl.	Tel., C.T.O., 1883; Clk., 3rd Cl., Engr. Dept., 1898; 2nd Cl., 1904.
Sc. W. (Suptg. Engr's. Off.)	Watson, E. W.	Clerk, 2nd Cl.	S.C. & T., Newc.-on-Tyne, 1889; Jr. Clk., Engr. Dept., 1899.

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RETIREMENT.

District.	Name.	Appointment.	Previous Service.
E.	Jenkin, J. . .	Suptg. Engr.	E.T. Co., 1858; Insp. 1st Cl., 1870; Supt. 2nd Cl., 1873; Suptg. Engr. 2nd Cl., 1878; Suptg. Engr., 1886

DEATH.

Sc. E. (Suptg. Engr. Off.)	Wilkes, G. S. .	Clk., 2nd Cl.	1871; Junr. Cl., Eng. Dept., 1878; Senr. Clk., 1885

TRANSFERS.

Name.	Rank.	District. From.	District. To.	Date.
Sinnott, J. . .	Asst. Suptg. Engr. Ldn.	Met. S.	Met. N.	14:6:09
Evans, W. M. .	Asst. Suptg. Engr. Prov	Ire. N.	Ire. S.	4:8:09
Fossett, J. H. .	Asst. Suptg. Engr. Prov.	Ire. S.	Sc. W.	10:8:09
Sell, L. J. . . .	Engr., 2nd Cl.	Met. S.	S.E.	27:6:09
Linford, W. J. .	Engr., 2nd Cl.	Met. S.	S.E.	8:7:09
Gwilliam, W. J. .	Engr., 2nd Cl.	E. in CO.	S.W.	22:8:09
Lockhart, J. . .	Engr., 2nd Cl.	Sc. W.	E. in CO.	16:8:09
Richardson, G. .	Engr., 2nd Cl.	E. in CO.	S. Mid.	1:9:09
Price, J. T. . .	Sub-Engr.	N. Mid.	S. Mid.	24:6:09
Black, R. H. .	Clk., 1st Cl. Prov.	Ire. S.	Ire. N.	1:5:09
Whittingham, N. S. .	Clk., 2nd Cl. Prov.	N. Wa.	S.W.	14:6:09
Ritchie, W. . .	Clk., 2nd Cl. Prov.	Sc. W.	Sc. E.	16:8:09
Storey, S. . . .	Clk., 3rd Cl. Prov.	Ire. S.	S.W.	3:6:09
Morris, G. L. . .	Clk., 3rd Cl.	Ire. N.	S.W.	4:6:09
Watson, W. G. . .	Clk., 3rd Cl.	Ire. N.	S.W.	4:6:09
Williams, R. E. .	Clk , 3rd Cl.	S.E.	N.W.	4:7:09

COMMUNICATIONS.

ALL Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, 22, G.P.O. West, London, E.C.

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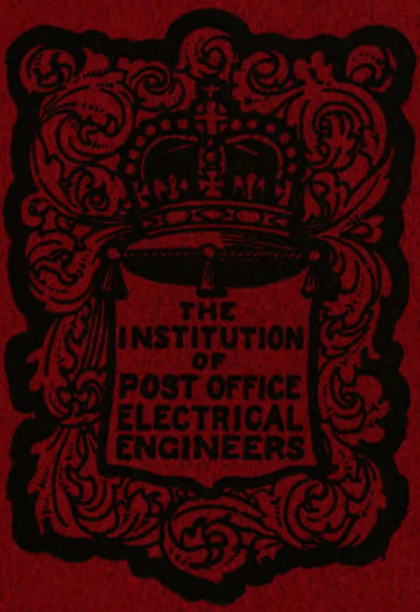
THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



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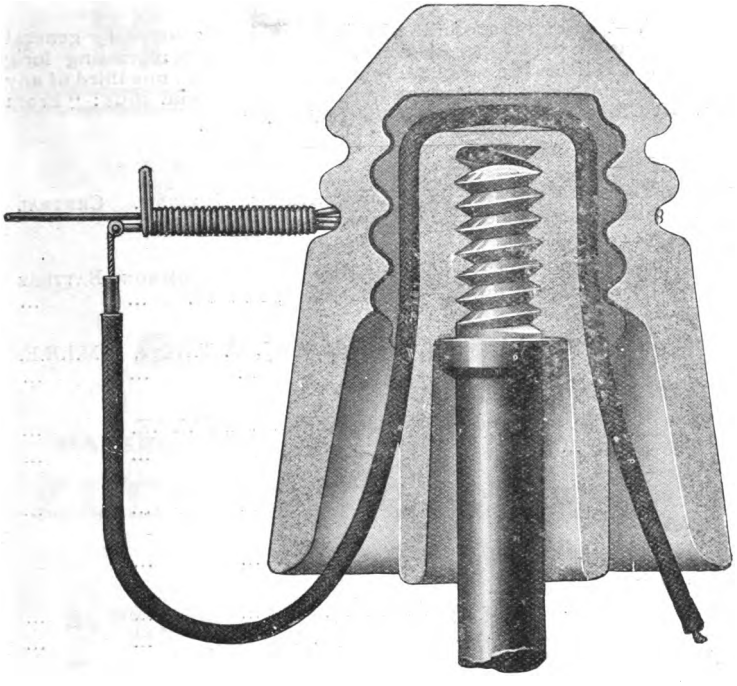

"The introduction of 24 volts pressure on telephone lines brought prominently to the front the question of insulation and taking 1000 lines under old conditions, on a wet day 40 per cent. tested under 100,000 ohms.; the use of Sinclair-Aitken leading-in insulators which introduces a dry section between the leading-in cable and the outside wire raised the insulation considerably, and under the same atmospheric conditions, only 23 per cent. proved to be under 200,000 ohms."

Extract from a paper on "Telephones" read by L. E. Wilson before the Institution of Electrical Engineers, November, 1909.

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The Post Office Electrical Engineers' Journal.

A QUARTERLY JOURNAL.

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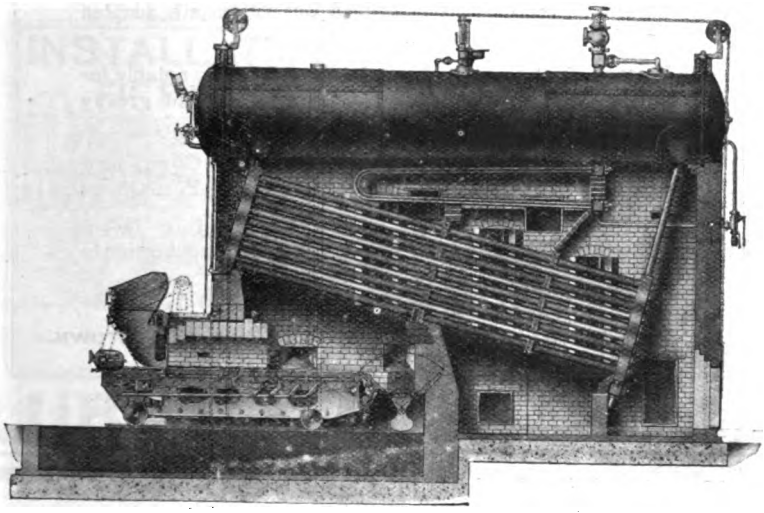

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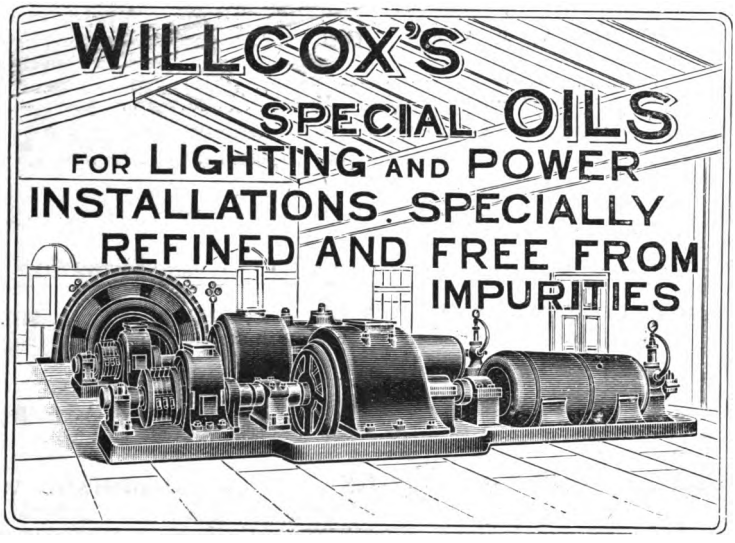

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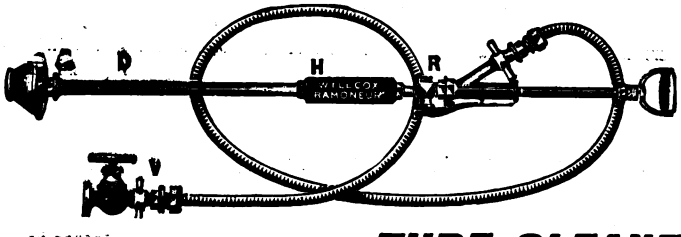

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New Post Office Building, Waterloo Street, Glasgow. Central Telephone Exchange on Top Floor.

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HARVARD UNIVERSITY
DEPARTMENT OF ENGINEERING

THE
Post Office Electrical Engineers' Journal.

GLASGOW TELEPHONE SERVICE: NEW POST OFFICE COMMON BATTERY EXCHANGE FOR 10,000 LINES.

By J. W. TURNER, A.I.E.E.,
Engineer-in-Chief's Office.

THE Corporation of the second city of the Empire has had a particularly unfortunate experience with its telephones. The "call-wire" system in use in the larger exchanges has long been regarded as obsolete. One of the aims of this system is to dispense with indicators, which in other systems are required for calling and clearing purposes. In order to accomplish this, upwards of twenty subscribers are given access to a common call wire, which terminates at an operator's position. Over this call wire all the twenty subscribers pass their requests for connections and for the clearing of the same. Each answering or "A" operator is given control of three call wires. The number of calls which can be dealt with per operator daily is, however, only 40 per cent. of the number which can be handled by an operator in a modern exchange.

The system is efficient when once the subscribers are in communication, but the means provided for obtaining communication and for the clearing of connections are most unsatisfactory.

The service given to each group of subscribers naturally depends upon the efficient working of the call wire, and to provide for interruptions, the switch-room equipment includes portable "breakdown" boards fitted with indicators. These boards are joined to the group of subscribers' circuits, associated with the interrupted call wire, by inserting plugs into the multiple, the subscribers being requested to call by generator until the call wire service is restored.

During the busier periods of the day it is necessary to set apart special operators who can tap each operator's position and, when the traffic demands it, re-distribute the call wires, relieving operators too heavily pressed and increasing the work of others who may not be fully employed. As might be anticipated, it often happens when these arrangements are in force that an operator at one point establishes a connection which an operator at another point is requested to clear. The service of a messenger is then requisitioned to find and clear the connection.

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Having these and other disadvantages in view the Post Office, in acquiring the Glasgow Corporation's telephone plant, regarded as inevitable the ultimate abandonment of the call-wire system.

The first call-wire equipment to be superseded is that of the Central Exchange. Some 5000 subscribers' circuits are connected to this exchange, and to make provision for these, and for the reception of subscribers' circuits to be transferred later from other exchanges in the vicinity, the Post Office decided upon the erection of a modern common battery exchange for 10,000 lines. Accommodation for the equipment was found upon the second floor of the new Parcels Post Office, Waterloo Street.

As will be seen from the floor plan upon Plate 1 it has been possible to accommodate the whole of the equipment upon one floor, an advantage rarely obtained for an exchange of this size. The location of the pillars supporting the roof is such as to allow spacious dimensions for the switchroom. The clear width between the suites of sections varies between 39 and 43 feet, and the ultimate clear length between sections will be 157½ feet. The switch-room is separated from the test-room by a partition built up along one line of pillars.

In reviewing the principal features of the equipment it will be convenient to follow as far as possible the route taken by the circuits, commencing at the point of entry into the building.

Test Room.

The paper-core lead-covered cables from the street reach the basement in ducts, fifty of which have been provided—ten from the north side and forty from the south side. From this point they are carried upon cable-bearers to the foot of a cable chute, thence up the chute to a mezzanine floor above the Linemen's rooms. Passing along the mezzanine floor they enter the test-room about three feet above the top of the main distribution frame, and at a point between the Wire Chief's desk and the nearest main wall. An overhead cable-run and support carries them from this point along the length of the main distribution frame. An end elevation of this support, showing its position with respect to the main frame, will be seen in Plate 2. The solid joints between the paper-core cables from the basement, and the silk and cotton-core cables to the main frame, are accommodated upon this support. They have a *staggered* formation, and occupy positions which keep the length of silk and cotton-core cable a minimum.

The distribution frames, meter and relay racks have been designed so as to be easily extended when an increased equipment is necessary. To obtain this facility the apparatus upon both sides of the frames has been arranged vertically. The main frame, meter rack,

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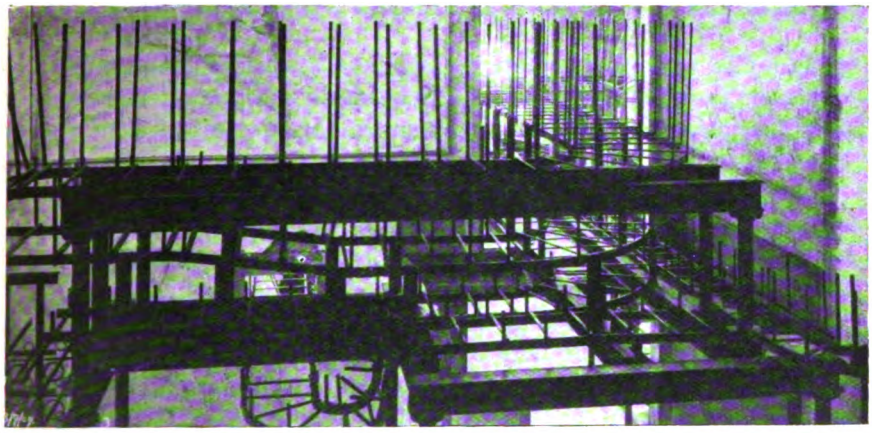
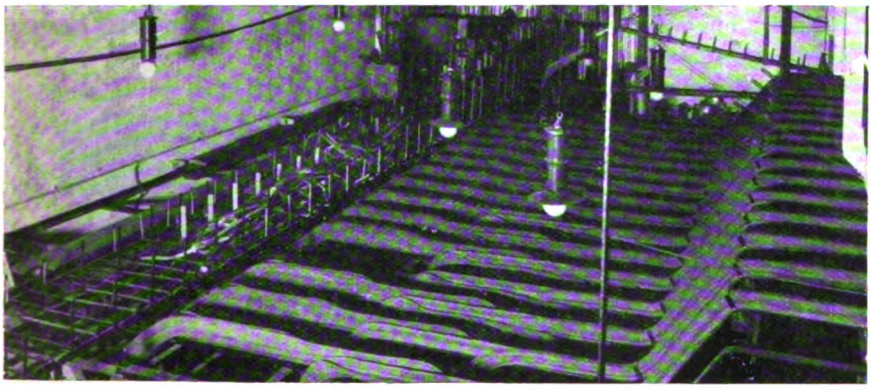
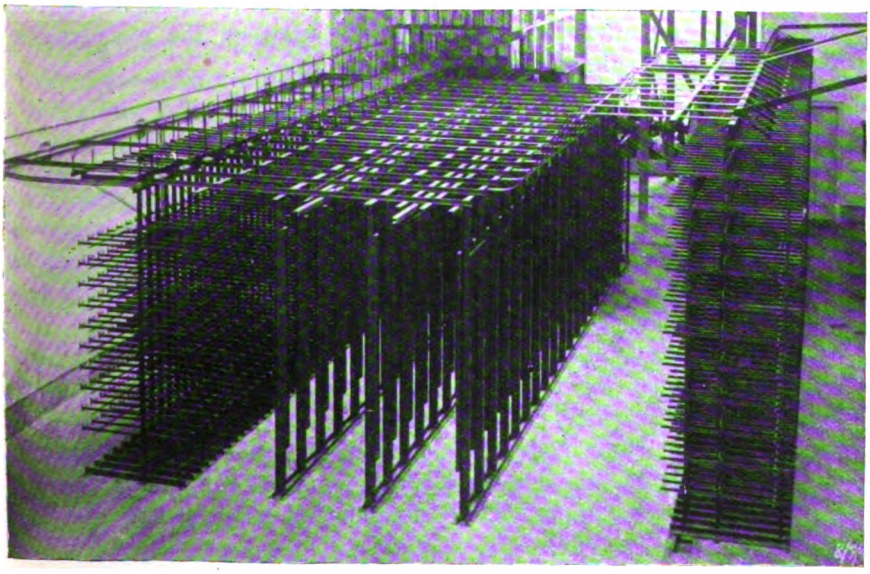


A.—Cable Support between Intermediate Frame and Sections.



B.—Cabling above Frames and Racks.



C.—Frames and Racks ready for Equipment and Cables.

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relay racks, and intermediate frame have, therefore, only sufficient capacity to meet the needs of the initial equipment, subsequent increase merely involving an extension of the frames and racks towards the linemen's room.

The line, or fuse side, of the main frame has a capacity for 16,560 circuits, arranged upon 69 verticals of 240 each; the other side, upon which heat coils and lightning protectors are fitted, having a capacity for 13,800 circuits, made up of 69 verticals at 200 each.

The method of cabling the main frame is also shown upon Plate 2. The silk and cotton-core cables are stripped of their lead covering from the top of the frame, and twelve groups of twenty pairs are formed out to the twelve fuse mountings. The group or bunch of forty wires, which serves a fuse mounting, passes behind and within the horizontal channel iron to which the mounting is fixed. The wires will therefore be protected from the cross-connection field.

To minimise fire risks sheets of uralite are fitted underneath each horizontal layer of the cross-connection field. Access to the equipment situated in the upper part of the frame will be obtained by means of travelling ladders, two of which have been provided for each side.

The meter rack has a capacity for 10,200 meters, and each of the two relay racks for 5400 line and cut-off relays. The intermediate frame has a capacity for 12,400 circuits. In the floor plan it is hidden by the cable runs to the switch sections, which are vertically above it.

Five other travelling ladders have been provided, as follows: One for the main frame side of the meter rack, one between the meter rack and adjacent relay rack, one between the relay racks, and one for each side of the intermediate frame.

SWITCHROOM.

The subscribers' switchboard consists of 28 equipped sections, 1 unequipped section (No. 29), 1 cable-turning section, and 1 one-third section. The whole of the relays, condensers, and resistance spools associated with the cord circuits are mounted upon apparatus racks about 6 ft. high and 2 ft. wide, erected adjacent to the running box at the rear. One apparatus rack is provided for each section.

The sections are of the 3-position 9-panel type, with subscribers' multiple capacity for 14,400 lines and equipment for 10,000 lines. Equipment is provided for 960 outgoing junctions multipled every two positions. Four designation strips per panel are provided for those jack strips which will accommodate outgoing junctions to more than one exchange. These designation strips are of the type shown in 1.

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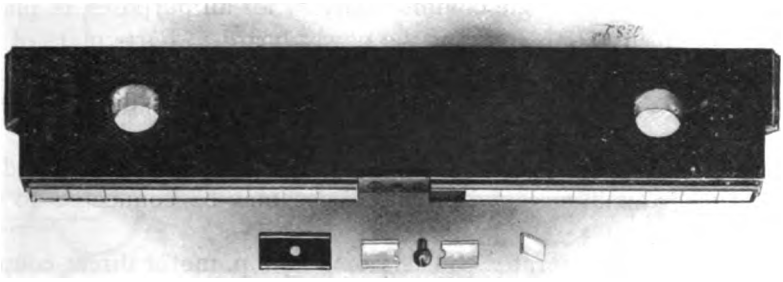
One hundred and twenty answering jacks and lamps are equipped upon the panels of each position, space being provided for 150. Each keyboard is equipped for 17 cord circuits and 40 outgoing order wire circuits.

The junction switchboard includes 12 equipped sections, 1 unequipped section (No. 13), 1 cable-turning section, and 1 one-third section. As in the case of the subscribers' switchboard, apparatus racks are provided at the rear for the accommodation of relays. Two racks, erected in line, are required for each pair of positions. The rack nearest to the test-room partition holds the repeating coils and condensers for the incoming junction circuits, while the relays for these circuits are mounted upon the other rack.

The junction and the subscribers' switchboards form separate suites of sections, and it has been possible to reduce the height of the



I.—Outgoing Junction Designation Strip.

panels upon the former by 6 in., as there is no necessity to provide space for answering equipment or for the same number of outgoing junctions as on the subscribers' switchboard. The subscribers' multiple capacity and equipment are similar to those on the subscribers' sections. The outgoing junction multiple is fitted for 360 junctions with a full complement of designation strips.

Equipment for 26 incoming junction circuits per position has been provided, and the wiring is such as to cater for quite a variety of circuits :

Incoming junctions from the Trunk Exchange
,, ,, ,, other C.B. Exchanges
,, ,, ,, call-wire ,,
,, ,, ,, call-key ,,
Two-way ,, ,, other P.O. ,,
Transfer circuits over which calls for code-ringing party lines will be passed
Lines from Information Desk.

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The wiring of junctions incoming from call-wire and call-key exchanges is arranged so as to facilitate conversion to C.B. working later if required.

Lead-covered cables in floor chases connect all apparatus racks to the switchboard. This method is also adopted for the ringing leads between the fuse board and the sections.

In the centre of the switch-room and connected by floor chases will be observed the *operators'* or *position* meter cabinet, a four-position information desk and desks for the use of the manager, chief operator and assistant chief operator. The utility of the various special circuits provided for these desks will be dealt with later.

Power Plant.

The fuse board, power board, and machines are erected in the test-room, and the single common battery for all purposes is placed in an enclosure at the rear of the power board. Particulars of the larger machines are given in Plate 3, which shows the connections of the charging and battery circuits. Two independent, direct-current, three-wire services have been brought into the building by the Corporation Electricity Department, and a switch is provided so that the 500-volt mains of either service may be connected to the motor generators.

Each motor generator consists of a 49 h.p. motor direct-coupled to a 30 kilowatt charging generator.

One of the ringing generators shown in Plate 4 is driven by a 250-volt direct-current motor, which may be connected to either of the 250-volt mains of the Corporation services by the switch shown adjacent to the one described above.

In view of the fact that two independent electricity supplies are available, the common battery has not been provided in duplicate. By means of a 1000 ampère, two pole, double-throw switch, shown at *A* in Plate 3, either charging generator may be connected to the common battery, *C.B.* Each charging generator is provided with a circuit-breaker of the "Stanley Edgewise" type, the action of which, being different from that of circuit-breakers hitherto fitted in Post Office telephone exchanges, may not be without interest.

In **2**, *h* is the iron core of an electro-magnet, *d* the reverse current armature, *e* the overload armature, *b* the series coil which carries the main current, *c* a high-resistance coil placed in series with a resistance *f* across the mains, and *k* the contacts which are opened when the circuit-breaker operates. Coils *b* and *c* are so wound that when the battery is being charged the flux produced by the current in *c* is in the same direction as that produced by the current in *b*.

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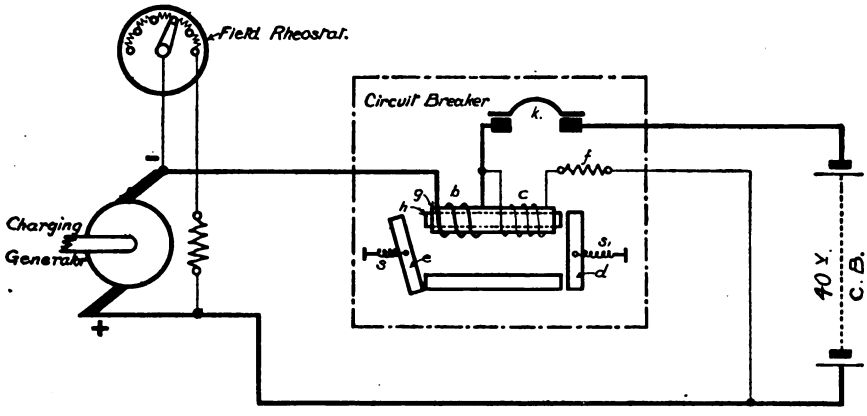
The resulting pull upon the armature *d* is sufficient to overcome the action of the spring S_1. With normal charging current in *b*, however, the pull upon the armature *e* is not strong enough to overcome the action of the spring *S*. The mechanism of the circuit-breaker is such that the attraction of the armature *e* or the release of the armature *d* will actuate a tripping device and open the contacts *k*.

If for any reason the generator becomes overloaded, the current in *b* excites the core sufficiently to pull up the armature *e*. On the other hand the armature *d* is released if the current in coil *b* reverses, as the fields produced in the two coils are then in opposition.

In order to prevent a sudden rush of reversed current demagnetising the core and magnetising it again in the opposite direction before the reverse current armature has had time to move away, the



2.—Circuit Breaker Connections.

core is provided with a copper jacket or tube *g* fitting close to the iron. A variation of magnetism in the core sets up induced currents in the tube, which act so as to retard the change producing them. The period during which the core is demagnetised, or nearly so, is therefore increased, and the armature *d* has time to move away.

The common battery (*C.B.* in Plate 3) consists of twenty chloride cells, having an ultimate capacity of 3230 ampère-hours at the 9-hour discharge rate. The initial equipment of plates is for 2720 ampère-hours at the same rate. The battery is protected by a 500 ampère fuse fitted in an air-tight fuse cabinet, which is erected close to the end cell at the negative pole. A 1000 amp. disconnecting switch *B* is provided in the negative lead from the battery. This switch will be opened when it is required to disconnect the battery from service. In such circumstances one of the generators would be previously connected up for the supply of current direct to the exchange. The connections of the ringing machines and interrupter

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attachments are given in Plate 4. Two belt-driven ringing generators have been provided, one of which is connected to a 40 v. direct-current motor served from the common battery whilst the other is driven by a 250 v. direct-current motor. On the armature shaft of each generator a divided ring is provided for the production of positive and negative pulsations required in the operation of party lines. Two high-speed tone-interrupters are also fitted to the shaft. The pitch of the note produced in one case is 400 and in the other 133 vibrations per second. The first-mentioned is used for busy-back and plugging-up circuits, and the second for the trunk tone-test upon incoming junctions from the Trunk Exchange. A combination of the two tones will be used when a "clear for trunk" circuit is installed. Geared at right angles to each generator shaft and rotating at a speed $\frac{1}{100}$th that of the generator armature are a number of slow-speed interrupters. Those marked "1-second ring, 2-seconds interval" in Plate 4 are required for the machine ringing arrangements upon the junction board, and the others shown to the left of the armature shaft in Plate 4 provide for the flashing signals which are required in the "busy-back" and "clear for trunk" circuits previously mentioned.

Slow-speed interrupters are shown for No. 8 machine only. Machine 6, however, has similar attachments, and the two 7-bar double-throw switches determine which of the two machines shall be connected up for service.

It is now proposed to leave the power plant, with its loads ranging up to 600 ampères, and to approach the many new and interesting circuits which carry milliampères only. The number of these circuits is such that upwards of two million soldered connections are involved.

Telephone Transmission System.

The transmission system is given in **3**. It will be recognised as a modification of that devised by Mr. J. S. Stone in 1892. The 40-volt common battery is connected to the tip and ring conductors of both sides of the cord circuits *via* 200$^{\omega}$ supervisory relay coils. For transmission purposes the two tip and the two ring conductors of the plugs are connected together by 2-mf. condensers. The presence of high impedances between the common battery and the conductors of the cord circuits will ensure an exceptionally "silent" system, while the efficiency of transmission with standard common battery telephone instruments and with subscribers' circuits of 300$^{\omega}$ resistance will be equal to that of other systems approved by the Department. For subscribers' circuits of lower resistance the efficiency of transmission will be slightly less, and for circuits of higher resistance slightly greater than other approved systems (see

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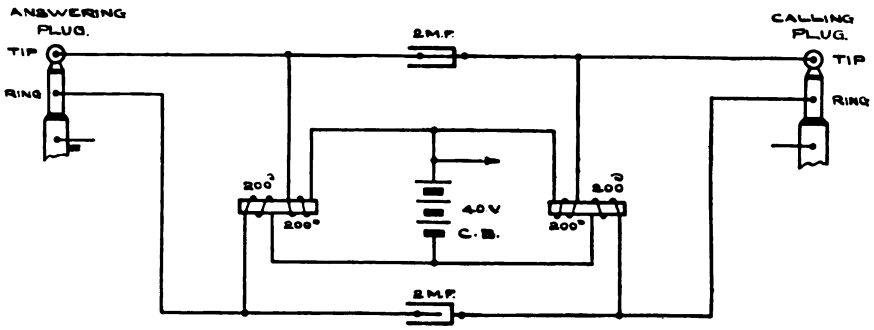
article by Mr. M. Ramsay, page 37, vol. 1). Transmission from subscribers' circuits of varying resistance will therefore be more uniform than is the case with systems of lower voltage. The higher voltage of this system also permits the use of relays having a larger number of turns, giving greater sensitiveness, and reducing the quantity of apparatus required in many of the circuits.

Subscribers' Line and Cord Circuits.

Skeleton diagrams of the subscribers' line and cord circuits are given in 4. The connections for the subscribers' station are those of the Department's standard common battery instrument. One or two new features will be observed in the subscribers' line circuit—the 40-volt line lamp, naturally most suitable for a 40-volt system, the 50ω cut-off relay and the double-coil line relay.

The type of small private branch exchange, or subscribers' inter-



3.—Transmission System.

mediate instrument, which requires current to be drawn from the "B" or ring wire of the exchange circuit without interference with calling or supervisory signals, will not be catered for in Glasgow. Hence there is no objection to the presence of a 200ω line relay coil between the negative pole of the common battery and the "B" wire of the circuit. The same argument holds good for the cord circuit where a 200ω supervisory relay coil connects the common battery to each "ring" conductor.

It was originally intended to provide a composite supervisory relay for each side of the cord circuit, but this idea has been abandoned in favour of the more simple arrangement shown in the figure. Briefly the operation of the circuits is as follows: The removal of the receiver from its rest by the calling subscriber closes the line relay circuit, and the operation of the line relay connects the 40-volt line lamp across the common battery. The line lamp glows, and the operator, noticing the signal, inserts the answering plug of

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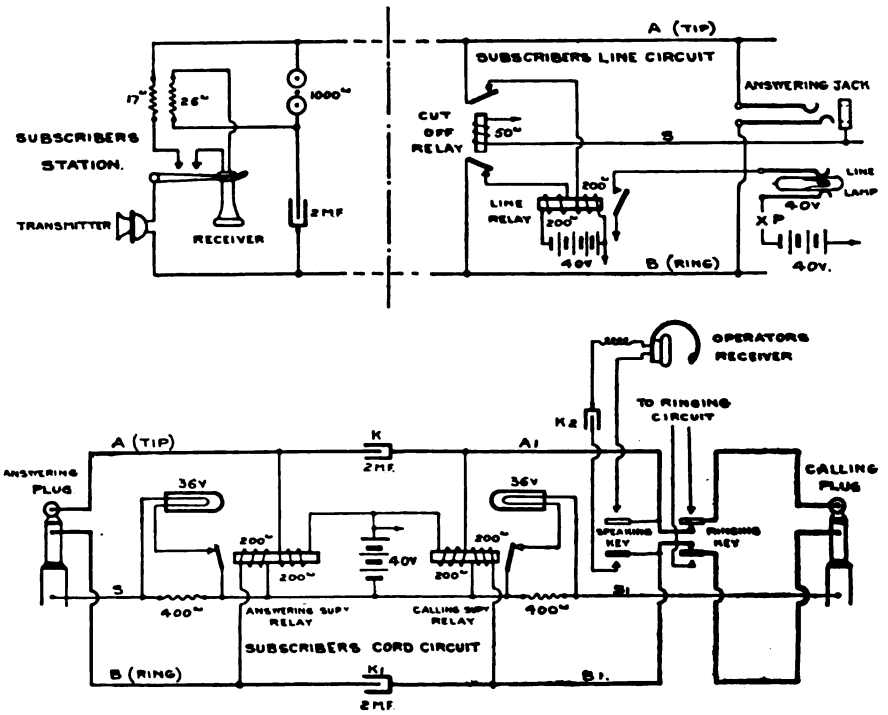
a disengaged cord circuit into the answering jack. Conductors *A*, *B*, and *S* of the cord circuit are thereupon connected to the corresponding conductors in the line circuit. The cut-off relay is energised by a current which flows *via* the 400ω resistance in the cord circuit, and the operation of this relay disconnects the line relay from the calling subscriber's circuit. As the subscriber's receiver is off the rest, the insertion of the answering plug into the answering jack closes the circuit for the answering supervisory relay with the result that the 36-volt supervisory lamp associated with this relay is disconnected. To take the required subscriber's number the operator



4.—Subscribers' Line and Cord Circuits.

throws the speaking key, an action which connects her telephone to the cord circuit. The number of the subscriber required having been ascertained she places the tip of the calling plug in contact with the socket of the nearest multiple jack of the required subscriber's circuit. If already engaged a current will be flowing through the cut-off relay of this circuit; and since all the multiple jacks, as their designation implies, are in multiple with each other and with the answering jack, a negative potential will exist at all the jack sockets of the engaged circuit. When the speaking key is thrown the tip of the testing-plug being at zero potential the charge

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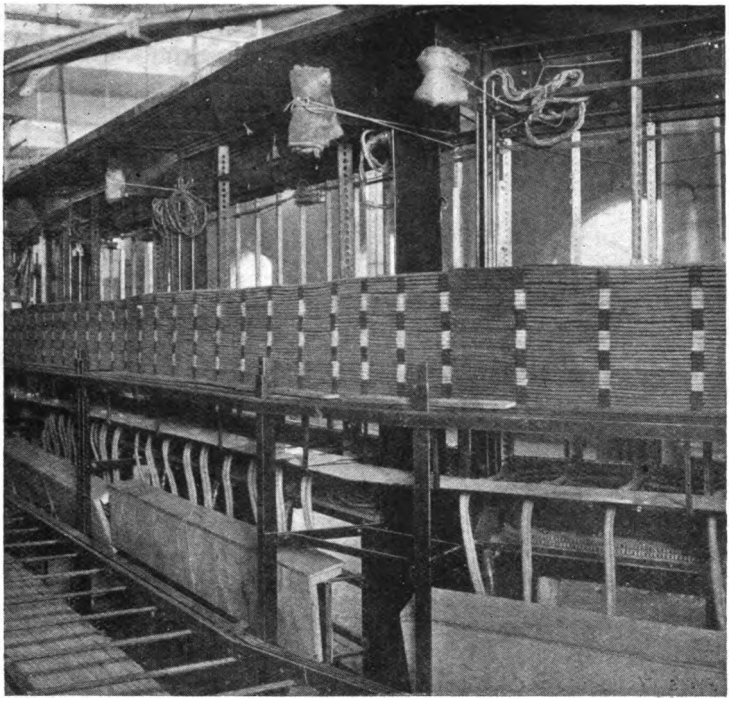
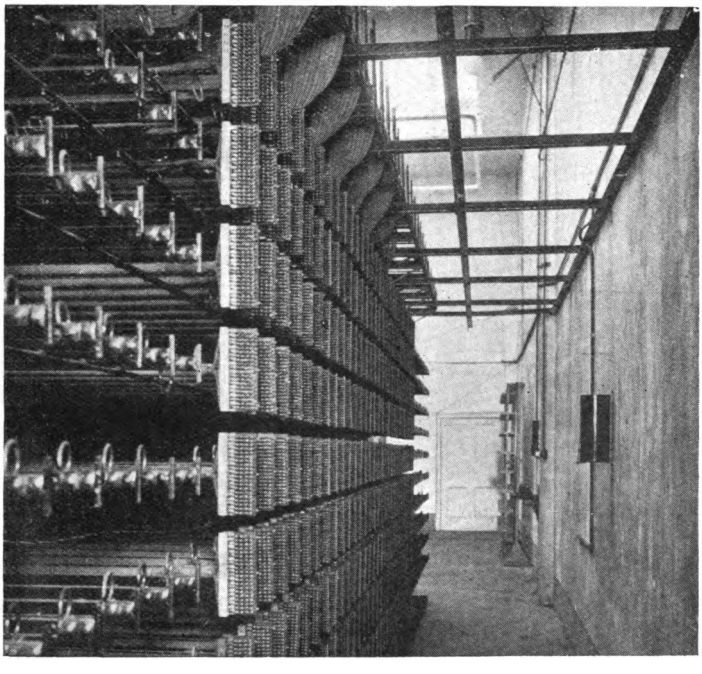


Rear View.—Subscribers' Board Multiple for 6300 Lines in Position.



Intermediate Frame.—Local Side.

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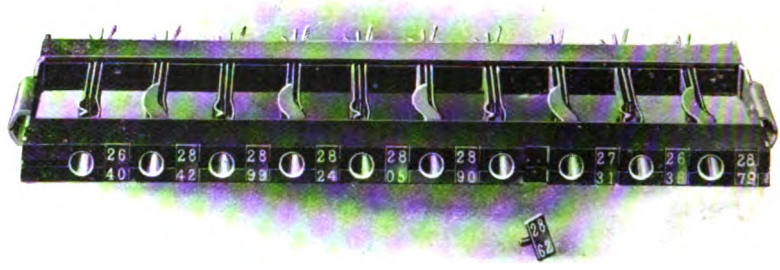
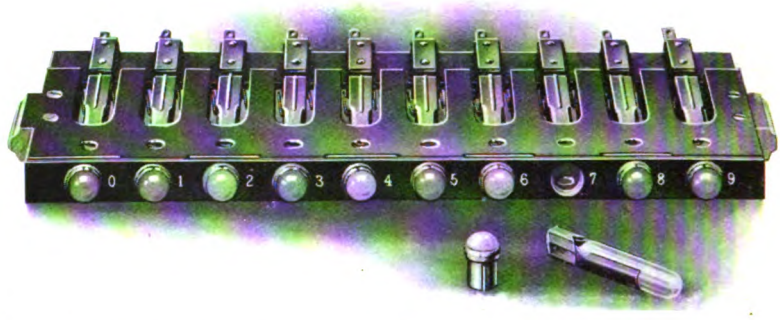
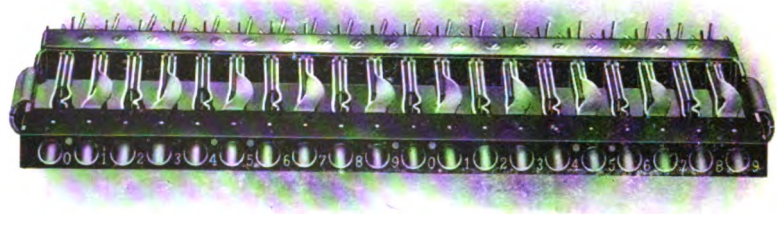
in condenser K_2 is a quantity proportional to the whole voltage of the common battery. When, however, the tip of the testing-plug and the socket of the engaged line are brought into contact the



5.—Ten Answering Jacks (one Label removed and shown separately).



6.—Lamp-Jack for Ten Line Lamps (One Opal Cap and Lamp withdrawn).



7.—Twenty Multiple Jacks.

voltage across condenser K_2 is reduced; a discharge follows, the path for which is *via* the operator's receiver, producing an audible click.

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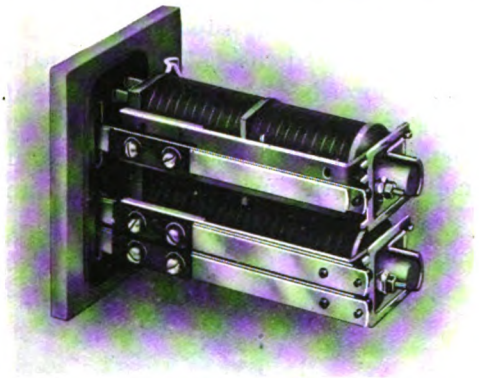
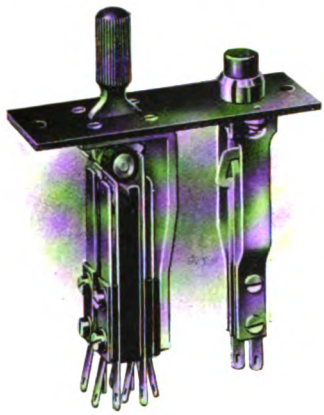
Had the required circuit not been engaged the multiple jack socket would also have been at zero potential and no click in the operator's receiver would have resulted.

If disengaged, the required subscriber is called by the operator



8.—Line Relay (above). Cut-off Relay (below).

inserting the calling plug into the jack tested and throwing the ringing key intermittently. The insertion of the calling plug establishes a circuit for the cut-off relay of the required circuit, taking out of action the line relay and line lamp of that circuit. While the ringing proceeds the 36-volt supervisory lamp associated



9.—Ringing and Speaking Key (left) and Meter Key (right).

with the calling supervisory relay will glow, there being sufficient voltage across the lamp filament when it is in multiple with the 400$^{\omega}$ resistance in the cut-off relay circuit. The operator continues to ring intermittently until between the ringing intervals she notices that the supervisory lamp darkens. This indicates that the sub-

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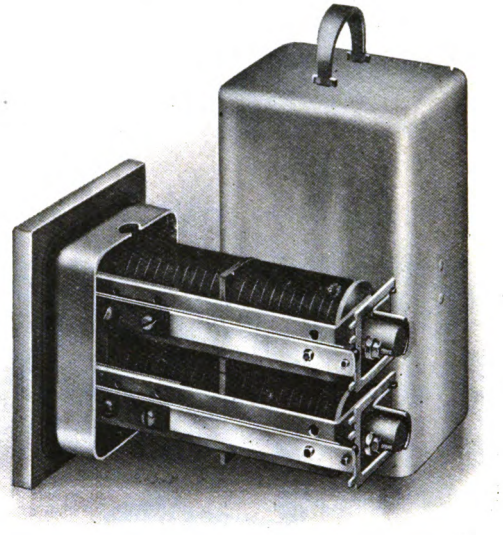
scriber required has removed his receiver from its rest, thus closing the circuit for the calling supervisory relay.

The subscribers' circuits are now connected for communication, and while the subscribers are conversing the supervisory lamps are disconnected. Current consumption during conversation is therefore a minimum. The answering supervisory lamp is controlled by the subscriber who originated the call, and the calling supervisory lamp by the called subscriber, providing double supervision as in other up-to-date systems.

The replacement of the receivers at the end of the conversation breaks the circuits of both supervisory relays, and both lamps



10.—Pair of Supervisory Relays with Cover.

glowing, the operator, after depressing the meter key for effective calls, will disconnect the lamp circuits by removing the plugs from the jacks.

5 to 10 indicate the general design of some of the items included in the subscribers' line and cord circuits.

Meter Circuits.

The meter circuits, both in arrangement and action, are similar to those used by the Department in London and Cardiff. The meter circuit for effective calls is given in 11. It is really in two sections, one associated with the subscriber's line circuit, the other with the answering side of the cord circuit. They are only brought together

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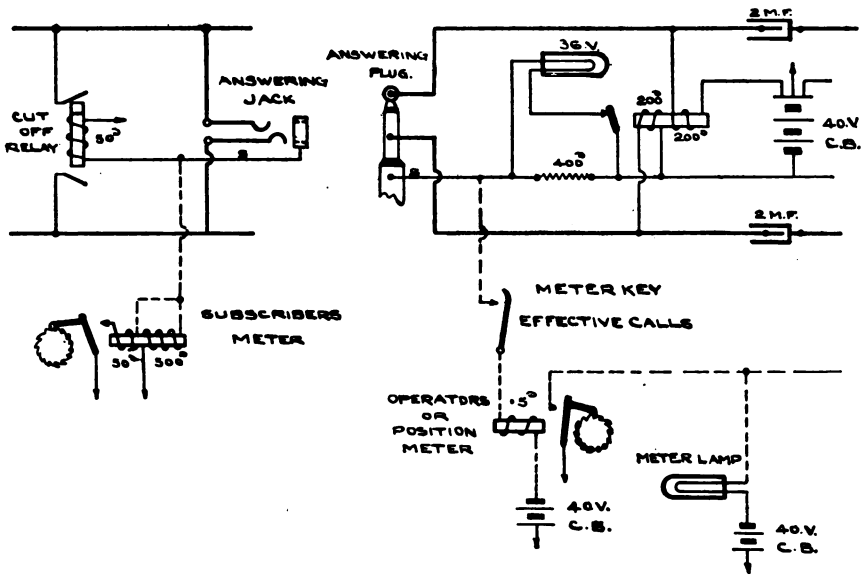
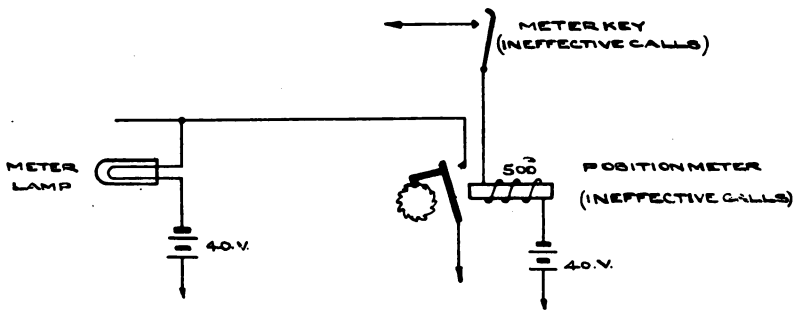
when the answering plug is inserted into the answering jack. Both sections of the circuit are represented by dotted lines. A meter key for effective calls is provided for each answering plug, and



11.—Meter Circuit for Effective Calls.

one " operator's " or " position " meter with lamp is provided for each " A " position. All subscribers' circuits will have meters, connected in multiple with the cut-off relays, as shown in the figure. Those readers who are acquainted with the meter circuit adopted on the



12.—Meter Circuit for Ineffective Calls.

Department's 24-volt C.B. equipments will observe one or two variations from present practice. Perhaps the most important is the absence of a separate meter battery. The resistance of the position meter is ·5Ω, and the low resistance winding of the sub-

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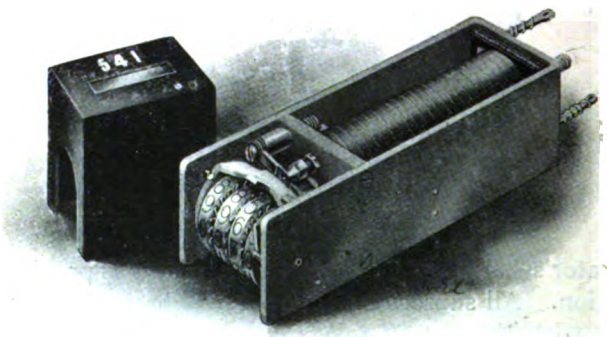
scriber's meter is 50ω. The action of the circuit is as follows: When the answering plug is inserted in the answering jack, one-eleventh of the current flowing in conductor *S* circulates in the 500ω winding of the subscribers' meter and ten-elevenths flows through the cut-off relay winding. Until the meter key is depressed the strength of current circulating in the 500ω winding is not sufficient to produce any movement of the meter armature. When, however, at the termination of the conversation, the meter key for effective calls is depressed, the 400ω resistance and 36-volt lamp are together shunted by the winding of the position meter, the resistance of which is only ·5 of an ohm. The current in the 500ω winding of the subscribers' meter is now increased six-fold, the armature is attracted and the reading of the meter increased by one unit. The attraction of the armature also connects the 50ω winding in multiple



13.—SUBSCRIBERS' METER.

with the 500ω winding, practically halving the resistance in series with the position meter. The latter responds to the resulting increased current, causing the meter lamp to glow and adding one unit to the position reading. The position meter therefore records all effective calls dealt with by the operator and the subscribers' meter all effective calls originated by the subscriber to whose circuit it is attached.

Each answering position will be provided with a special meter key and meter for the purpose of recording ineffective calls. The connections are given in **12**.

13 shows the type of meter which is being fitted.

"A" OPERATOR'S TELEPHONE CIRCUIT.

The "A" operator's telephone circuit is given in **14**. As in other systems adopted by the Department the common battery is utilised

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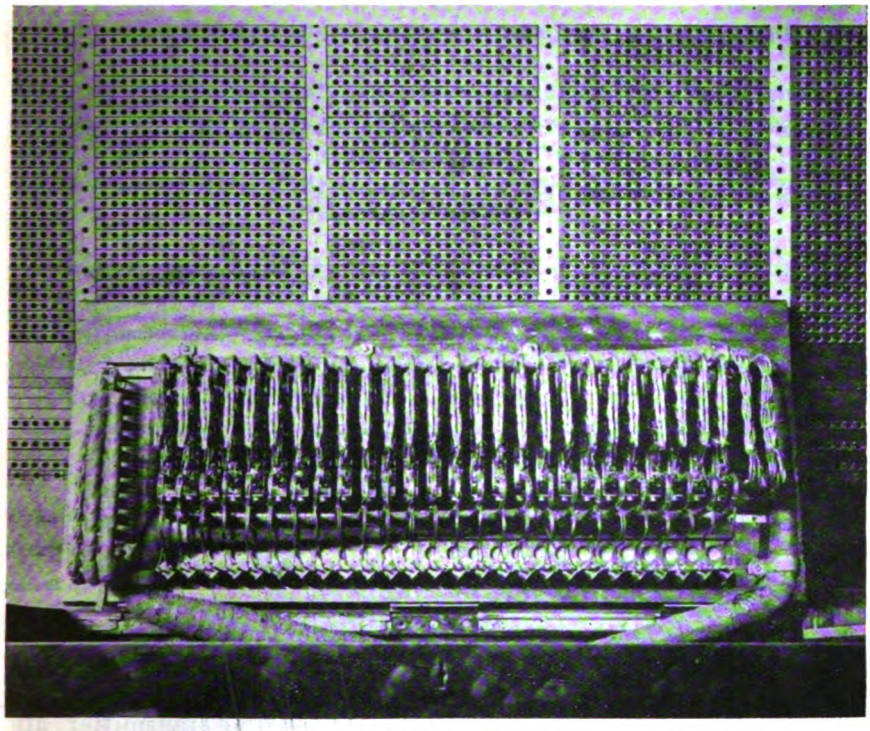
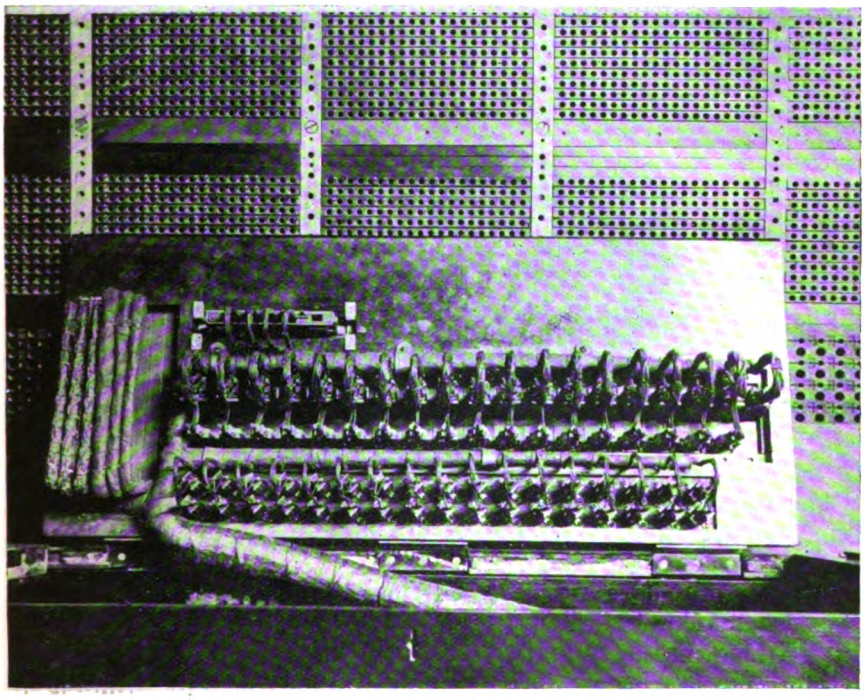


WIRING.—JUNCTION KEYSHELF.



WIRING.—SUBSCRIBERS' KEYSHELF.

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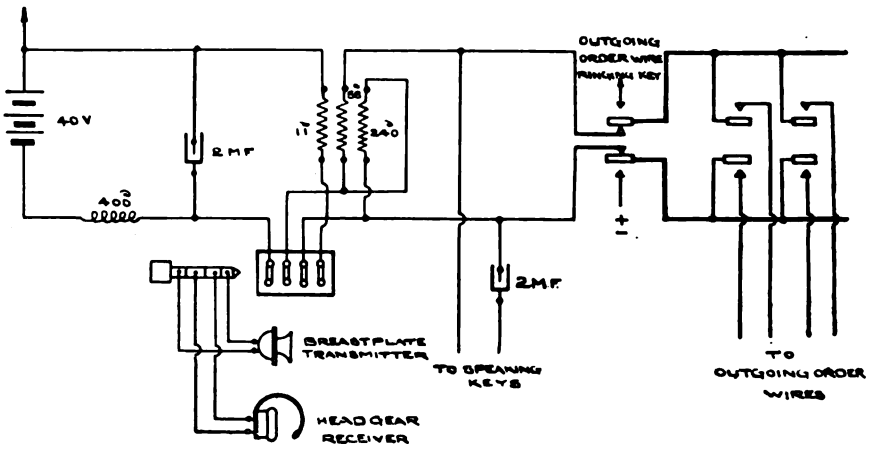
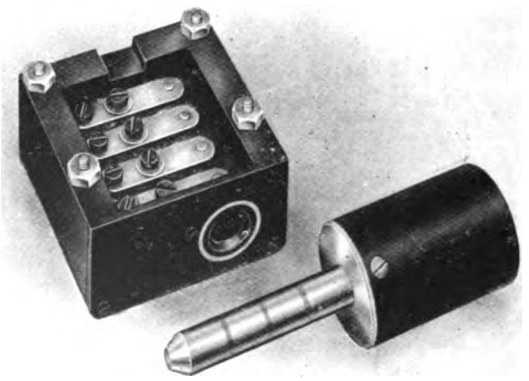
for the supply of current to the operators' transmitters. The necessary reduction of voltage across the transmitter is obtained by the insertion of a 400ω retardation coil in series with the transmitter, whilst with the view of sharpening the variations of current



14.—"A" Operator's Telephone Circuit.

in the 11ω primary winding this winding and the transmitter are shunted by a 2-mf. condenser. The combined action of the 400ω retardation coil and the 2-mf. condenser also shields the operator's telephone circuit from cross-talk or other disturbances.



15.—Jack and Plug of Operator's Telephone Circuit.

It will be noticed that the existing practice of the Department has been followed in the method adopted for the diminution of "side tone" in the operator's receiver. The 58ω or tertiary winding really acts as the secondary winding, while the 240ω winding is joined across the receiver in such a way that while its action assists

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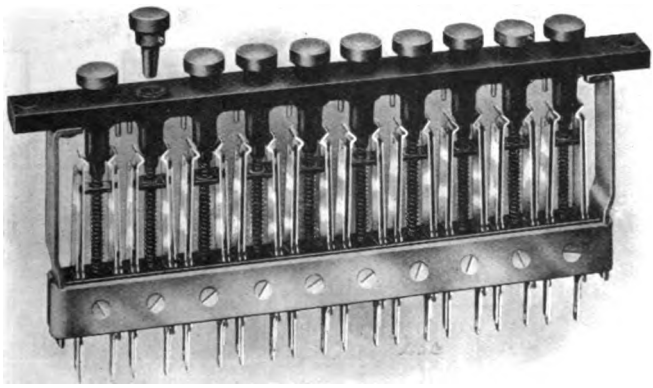
that of the 58ω winding in the subscriber's circuit, it opposes the action of that winding in the operator's receiver.

"A" Operator's Ringing Circuit.

The ringing circuit for an "A" operator's position is given in **17**.

The equipment upon both "A" and "B" boards provides for the selective ringing of four-party lines on the Thompson and Robe system, a system which has been provided for in the majority of the Department's C.B. Exchanges. A party-line switching key, marked *S* in the diagram and illustrated in **18**, is fitted upon each A position. When the springs of the party-line key are in their normal positions



16.—Ten Outgoing Order-wire Keys (One Button withdrawn).

the outer (B wire) springs of the cord circuit ringing keys are connected to the ± brush of the generator and the outer "A" wire springs of these keys to earth, so that ringing currents may be applied to ordinary subscribers' circuits by merely throwing the ringing key associated with the calling plug used. If, however, party No. 1 upon a four-party line is required No. 1 button upon key *S* would be depressed before the operation of the cord circuit ringing key. For party 2 No. 2 button would be depressed and so on. The various descriptions of ringing current, as may be traced from the diagram, are:

For ringing upon one-party or ordinary subscribers' circuits—

± to "B," earth to "A."

For ringing upon four-party lines—

Party 1 { − pulsations to "B." / Earth to "A."

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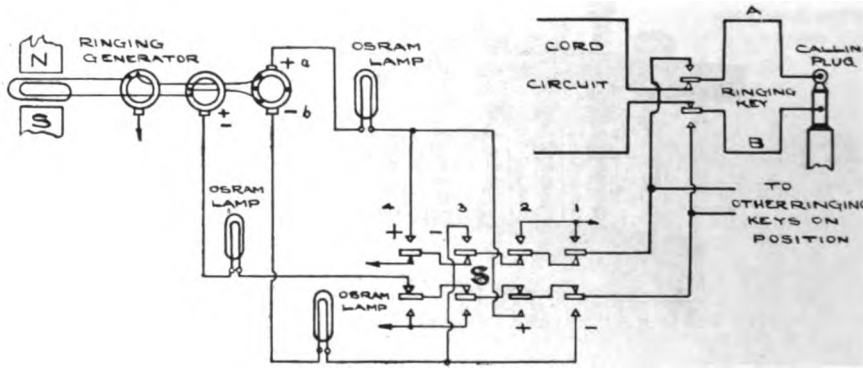
Party 2 { + pulsations to "B." / Earth to "A."

Party 3 { Earth to "B." / − pulsations to "A."

Party 4 { Earth to "B." / + pulsations to "A."

When the party required has responded to the call the A operator will depress the red button to restore the switching-key springs to their normal positions. This red button is shown without springs in **18**.

Carbon brushes, marked *a* and *b*, which bear upon an additional ring divided into two segments and fitted to the generator armature, collect the positive and negative pulsations respectively. The Thompson and Robe party-line system requires that between the



17.—"A" Operator's Ringing Circuit.

pulsations the brushes referred to shall be connected to earth, and this is arranged by joining the spare segment of the divided ring to the earthed ring by an internal insulated conductor. Following the Department's existing practice, three resistance lamps will be fitted to each subscriber's position in order to prevent too heavy a drain upon the ringing generator when an operator happens to connect it to a faulty circuit. Osram lamps having the advantage of a positive temperature co-efficient are provided for this purpose. One of these lamps is seen in **19**. In describing the cord circuit (**4**) it was explained that arrangements have not been made for the supply of current over "B" wires for small branch-exchange service; and for this reason it is not necessary to provide a ringing circuit which supplies alternations to the "A" wire and connects the common battery to the "B" wire, as is done in the Department's London exchanges.

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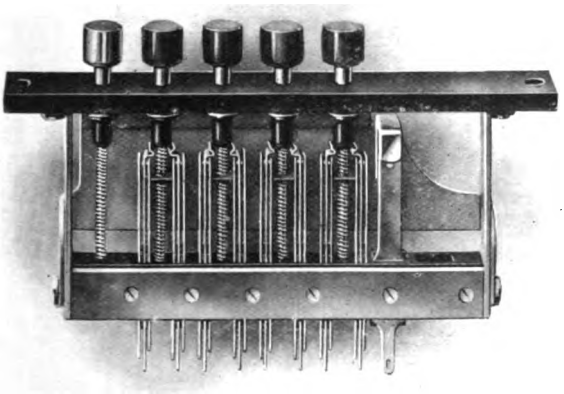
Plate 5 incorporates 3, 4, 11, 12, 14, and 17, showing their relationship one to another.

Wiring of Subscribers' Line Circuits.

In Plate 6 an attempt has been made to divide the wiring of a subscriber's line circuit into the nine important sections representing respectively connections upon the main distribution frame, relay rack, intermediate distribution frame, multiple junction board, multiple subscribers' board, meter rack, fuse cabinet, apparatus rack

18



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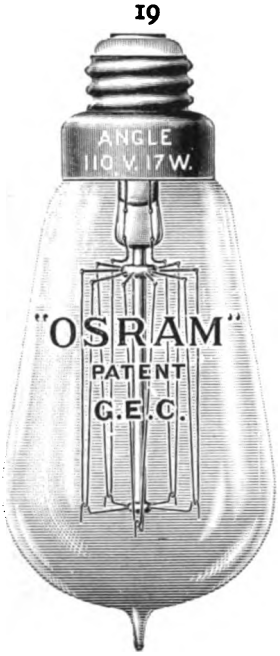

18.—A Operator's Party Line Switching Key.
19.—Osram Ringing Resistance Lamp.

at rear of subscribers' board, and the answering position. Upon the line side of the main frame the Department's standard 3-ampère glass-tube fuses are provided. A mounting for 40 glass-tube fuses (20 circuits) is illustrated in **20**.

21 shows the method of assembling the lightning protectors and heat coils upon the exchange side of the main frame.

As will be seen from the floor plan the relay racks are erected between and parallel to the main and intermediate distribution frames so that it is both convenient and economical to terminate the 42-wire cables from the protector side of the main frame upon the

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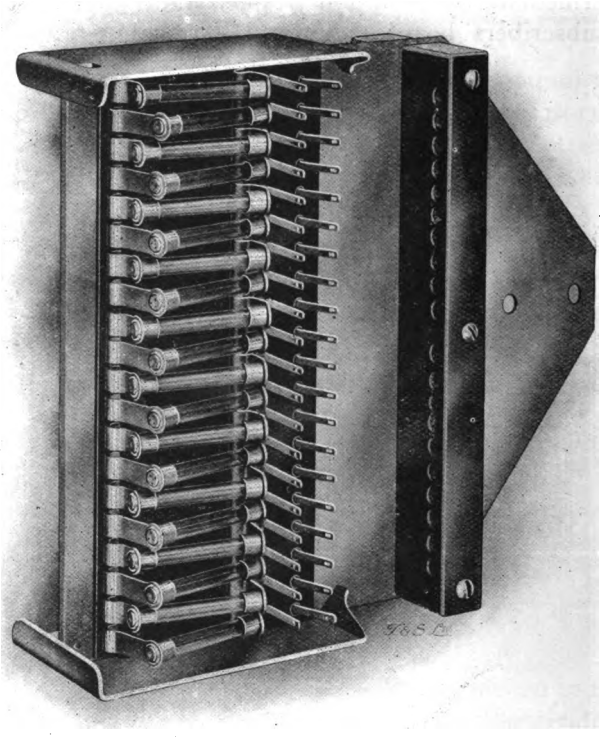
relay rack instead of the intermediate frame as has been the practice hitherto.

A detailed description of this diagram would, it is feared, unduly tire the reader, and, indeed, such a description scarcely seems necessary, as the arrangement, if examined in conjunction with the line circuit given in 4, will be found to be self-explanatory. Two points of detail may be mentioned however.

A reader unaccustomed to wiring conditions might be perplexed



20.—Mounting for Forty Fuses. Line Side, Main Distribution Frame.

by the references to 21-wire, 42-wire, 63-wire, or 84-wire switchboard cable. Subscribers' line circuits are invariably wired in groups of twenty. Where four wires have to be provided for each circuit between two points—from intermediate frame to the relay rack for instance—they are accommodated in 84-wire cables, which are made up of 21 pairs and 42 single wires, twenty sets of four for the group of twenty circuits and one set spare. Similarly, where one, two or three wires per circuit are required, 21-, 42-, or 63-wire cables respectively are used.

The pilot lamp, although fitted into a large size socket with cap

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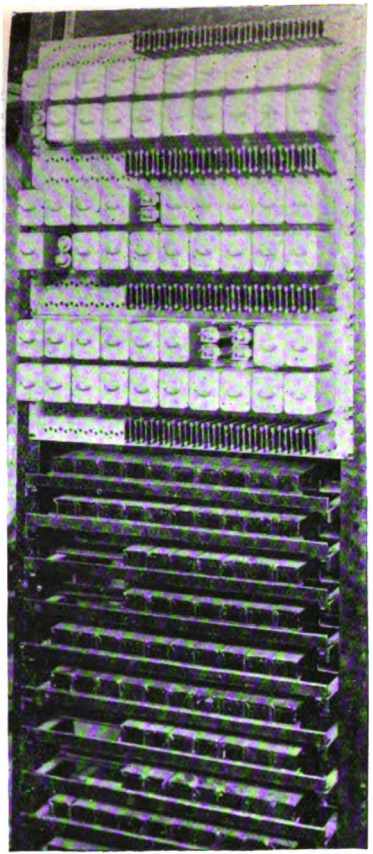
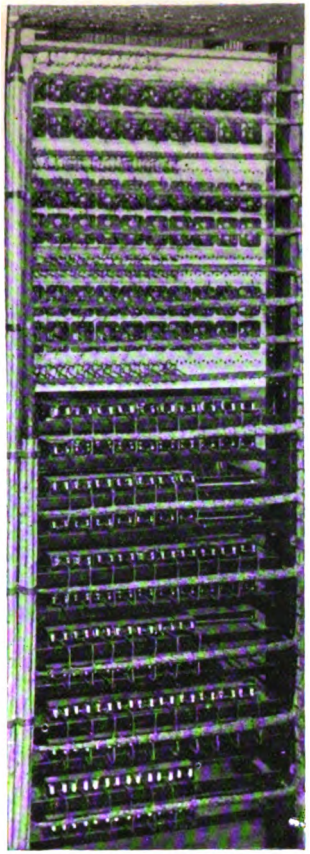
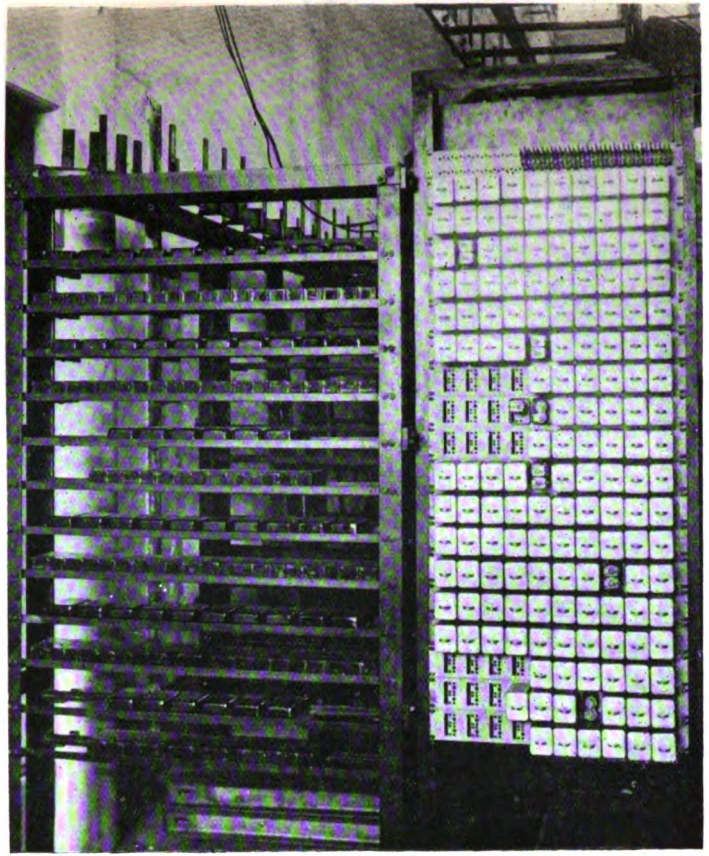


APPARATUS RACK. — SUBSCRIBERS' BOARD, RELAYS AND RESISTANCES ABOVE, CONDENSERS BELOW.



APPARATUS RACK.—SUBSCRIBERS' BOARD, WIRING.



APPARATUS RACKS.—JUNCTION BOARD, REPEATING COILS AND CONDENSERS TO THE LEFT, RELAYS TO THE RIGHT.

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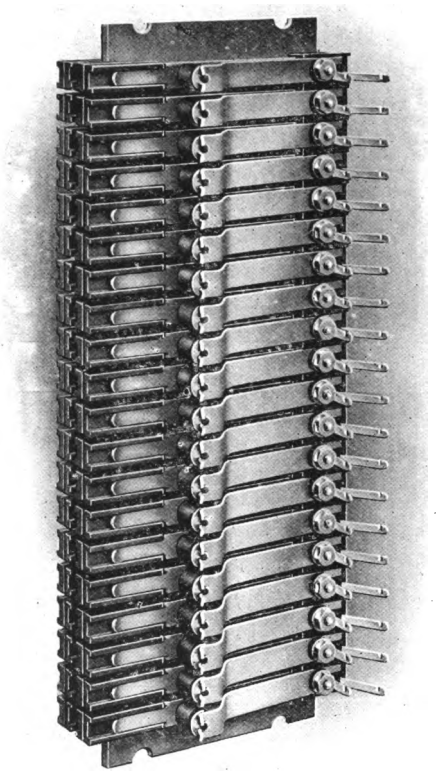
to correspond, will be of the ordinary line-lamp type. The lamp with its socket is given in **22.**

Some of the most interesting departures from present practice will be found in the arrangements for junction working.

B Operator's Telephone Circuits.

The connections of an "incoming junction" or B operator's telephone circuit for order-wire working are shown on Plate 7.



21.—Lightning Arresters and Heat Coils. Exchange Side, Main Distribution Frame.

The incoming order-wires terminate upon break-jacks on one of the panels in front of the operator. These jacks are provided in order that a faulty order-wire may be rapidly substituted by a good incoming junction, it being necessary for the operator merely to insert the plug of the incoming junction selected for the purpose into the break-jack associated with the faulty order-wire. It will be seen that the insertion of the plug would disconnect the faulty order-wire from

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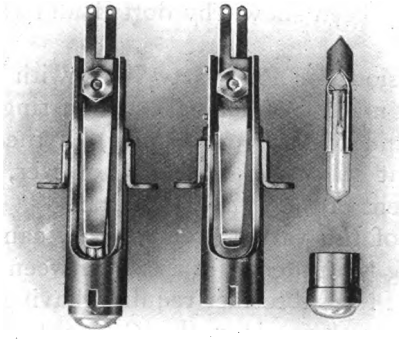
the operator's circuit and connect the incoming junction in its place. All the incoming order-wires terminating at a junction position are connected in multiple at the break-jacks, and thence to the main springs of the so-called "position-throwing" key, the object of which is to transfer groups of incoming order-wires to the next succeeding positions during slack periods. In order that the operator in charge of the position upon which these circuits are concentrated may test with any incoming junction plug under her control without removing the plug attached to the head telephone set, it is arranged that the common connection which normally joins all the plug tips of a position together and to the 58$^{\omega}$ winding of the operator's induction coil is also transferred to the succeeding position by the action of this key.

A transient ringing current received over an order-wire from a distant exchange is converted into a permanent signal by the locking action of the second winding of the order-wire relay. When the



22.—Two Pilot Lamp Sockets—one with Lamp and Cap in Position, the other with Lamp and Cap Removed and shown separately.

operator attends to the call she throws the "re-setting" key, breaking the retaining circuit.

The function of the 50$^{\omega}$ resistance spool in series with the 58$^{\omega}$ winding of the induction coil is to diminish the shunting effect upon the required subscriber's cut-off relay when the junction operator is testing.

No order-wire relay will be required upon those B positions which are set apart for ringing junctions (lower figure, Plate 7). A position lamp associated with the ringing junctions and the night alarm circuit will, however, be provided. The springs of the position throwing key which for order-wire working accommodate the incoming order-wires will be used upon ringing positions for the termination of the speaking-key commons, so that when the position-

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throwing key is operated the speaking-key connections will be transferred to the next succeeding operator's position.

With a view to the operation of the junction supervisory relay when the B operator responds to a call upon a ringing junction, a 1400ω retardation coil is placed across the common leads of the speaking keys. The operation of this relay when the B operator responds to a call provides for a signal being given to the distant A operator, also for the release of the machine ringing-key at an intermediate point if the operator there, when using the junction to connect a third exchange, had inadvertently depressed this key.

Incoming Junctions from C.B. Exchanges.

An incoming junction from a C.B. exchange, given in Plate 8, has been selected for detailed treatment as it embodies the principles upon which the various incoming junction circuits for this exchange are built up. In order that the speaking and signalling sections of the circuit may be readily distinguished from the machine-ringing circuit the latter has been shown by dotted and the former by full lines.

Hitherto provision for four-party lines with selective ringing facilities has been made by placing the five ringing keys (one for ordinary ringing and one for each party) in the speaking circuit. In the arrangement shown in Plate 8, however, the ringing keys are quite independent of the speaking circuit.

The functions of the various relays, etc., can perhaps best be described by taking the progress of a call between exchanges *A* and *B*. The number of the subscriber required having been passed over the order-wire by the *A* operator, the *B* operator will assign a disengaged junction for the connection. The *B* operator then proceeds to apply the engaged test by placing the tip of the junction plug in contact with the socket of the nearest multiple jack of the circuit required. Simultaneously the *A* operator will insert the calling plug in the outgoing junction jack at *A*. Relay R_1 at *B* is operated by current flowing through the 12,000ω winding, but the resistance of this winding is high enough to prevent an operating current flowing through the calling supervisory relay at *A*.

If the required circuit is engaged the application of the plug tip to the jack socket will bring the 58ω tertiary winding of the *B* operator's induction coil and the 50ω resistance spool across the cut-off relay of the required circuit. This does not interfere with the operation of the cut-off relay, but a current of approximately 30 milliampères passes through the tertiary winding of the induction coil, producing a momentary induced current in the secondary circuit, included in which is the *B* operator's receiver. The diaphragm

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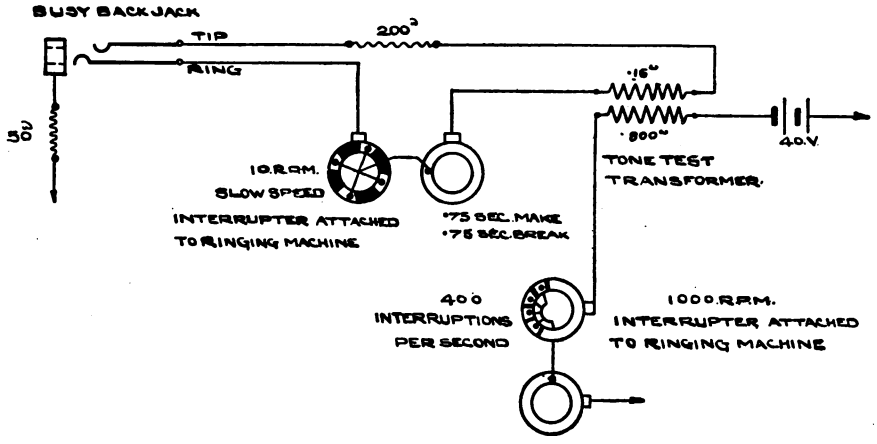
of the latter responds to this momentary current, producing an audible click, indicating to the operator that the line required is engaged. A slight digression should perhaps be made here to explain that the secondary circuit upon a position worked by order-wire is completed *viâ* the order-wire relay and condenser. At a ringing junction position, however, there will be no order-wire relay or condenser, and the secondary circuit is only closed if the speaking key of the ringing junction in use has been thrown before testing—a condition which is also essential upon an *A* operator's position. To return to the junction circuit, let it be assumed that the line tested is engaged. The *B* operator, hearing the click, will insert the junction plug into a busy-back jack operating relay R_2 and disconnecting lamp *L*.



23.—Busy-back Circuit.

Busy-back Circuit.

The connections for the busy-back jack are similar to those adopted in the Department's existing busy-back circuit. The connections in explanatory form are given in **23**. The tip and ring springs of the jack are connected to a loop of approximately 200ω resistance which is automatically open and closed every ¾ second. While the 200ω loop is closed relay *R* in the junction is energised and the 12,000ω winding of relay R_1 shunted by the 27ω winding. The operation of relay R_1 is maintained, but the resistance in series with the calling supervisory relay at A is so far reduced as to provide a current of sufficient strength to operate it. The supervisory lamp at A darkens in consequence. It will be noticed that the 200ω loop in **23** has the low-resistance secondary winding of a tone test transformer in circuit, so that while the loop is intact a tone

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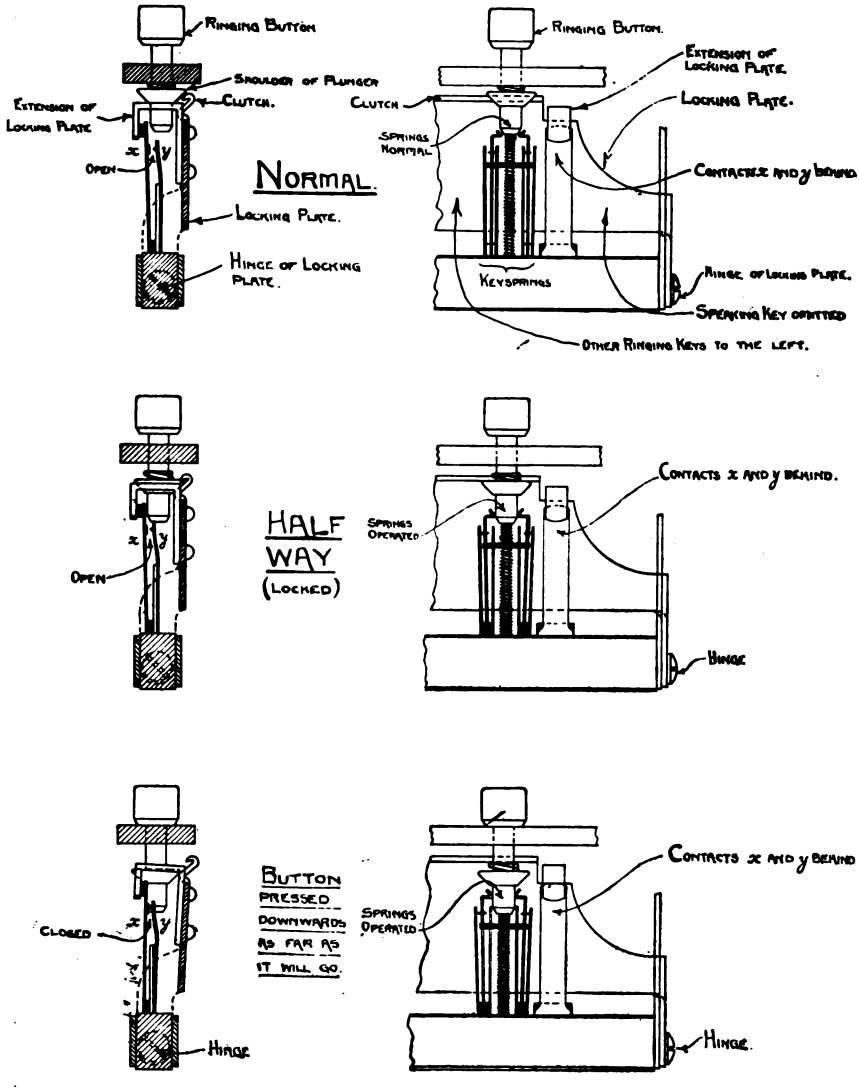
will be transmitted *viâ* the repeating coil to the waiting subscriber who originated the call at A.

When the loop is open the 27^{ω} winding of relay R_1 is disconnected, causing the supervisory lamp at A to glow. In addition



24.—Machine Ringing Key.

the tone is removed from the circuit. The effect of inserting the plug into the busy-back jack is therefore to produce a flashing of the supervisory lamp at A and an intermittent tone in the waiting subscriber's receiver. The subscriber is trained to recognise this intermittent tone as the engaged signal, and will on hearing it restore

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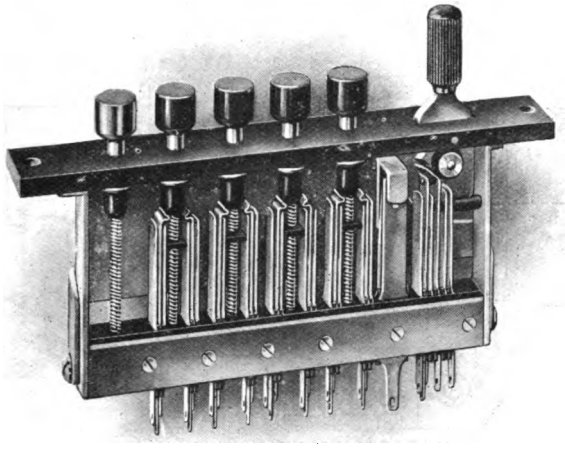
the receiver to its rest. If, however, he does not understand the signal the A operator's attention to the circuit is assured by the flashing of the calling supervisory lamp. The removal of the calling plug by the A operator de-energises relay R_1 at exchange B, causing lamp L to glow. The B operator then removes the junction plug from the busy-back jack, disconnecting the circuit for relay R_2 and darkening lamp L.

Machine Ringing Arrangements.

To take now the case when the subscriber required is not engaged. The B operator, after testing as previously described and finding the line disengaged, will insert the plug into the multiple



25.—Speaking and Machine Ringing Keys.

jack and momentarily depress one of the five ringing buttons, depending upon the character of ringing current required (see description of **17**).

The B operator may now proceed to deal with other calls as the ringing of the subscriber required is performed automatically. By the agency of relay R_2 lamp L was darkened when the plug was inserted into the multiple jack, and it does not glow again until the calling plug is removed from the outgoing junction jack at exchange A.

The depression of any one of the five ringing buttons must close the circuit of relay R_3, as the machine ringing circuit, as a whole, is disconnected from the junction circuit until this relay is operated. It is arranged, therefore, that the locking plate, which is common to all the five buttons, shall close the circuit of relay R_3 by bringing contacts x and y together when any button is pressed down as

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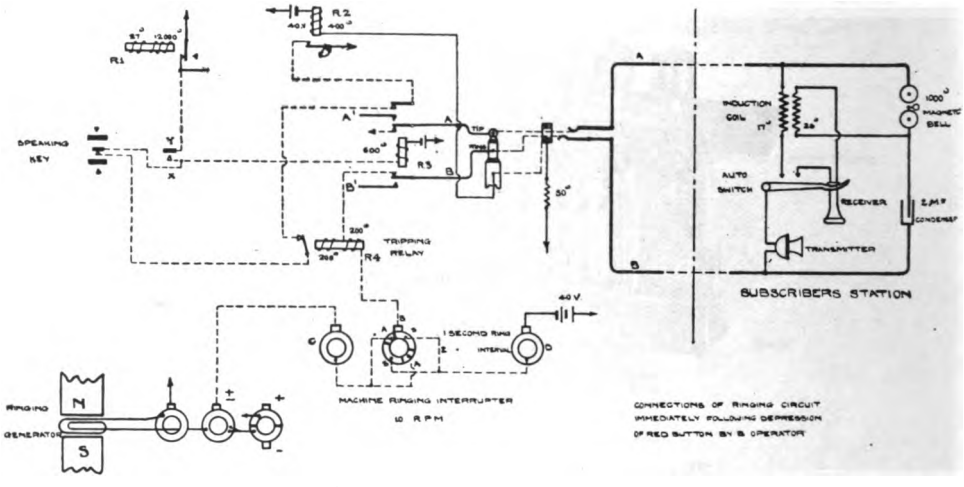
far as it will go. When released by the B operator the button travels upwards until it engages the clutch of the locking plate, at which point it is halfway between its normal position and that when pressed down by the operator. In this half-way position the key-springs underneath the button, if any, are operated, but contacts x and y are separated again. In the ordinary way the button remains in this position, even when the ringing circuit is automatically disconnected from the junction circuit, until some time later another button is depressed by the B operator, forcing the locking plate outwards and removing the clutch from the shoulder of the plunger. A reference to **24** will make the action clear.

The fact that the button remains in the half-way position is of advantage in that the B operator, if asked to ring a subscriber a



26.—MACHINE RINGING CIRCUIT.

second time, is aware of the particular button of the five which was previously depressed.

Turning again to Plate 8 and assuming that the circuit required is not a party line, the B operator, noticing that lamp L is out and that therefore the junction has been "taken" at the outgoing end, will depress the red button. This closes contacts x and y and establishes a circuit for relay R_3 *viâ* the springs of relay R_1. Relay R_3 is energised and the required subscriber's circuit is connected to the ringing circuit, shown dotted in the figure. Relay R_3 does not assume its normal condition again when the ringing button is released, as its armature is retained by a current which flows between earth and point x *viâ* springs of relay R_2, its own springs, springs of tripping relay R_4, and the inner springs of the speaking key. The path for this retaining current will be more easily followed

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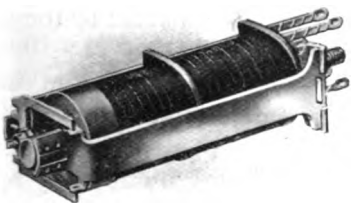
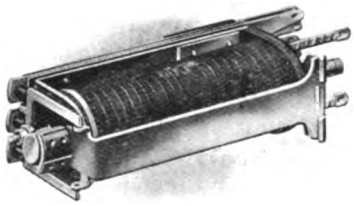
in **26**, which represents in skeleton form the connections of the ringing circuit immediately the red button is depressed by the B operator. While the connections shown in **26** obtain, the subscriber's bell rings for periods of one second separated by non-ringing intervals of two seconds. This is provided for by arranging that relay R_3 when energised connects the tip or *A* wire of the subscriber's circuit to earth and the ring or B wire to the ringing generator *viâ* an interrupter geared to the ringing machine armature which closes the circuit for one second and opens it for two seconds. Referring to **26** it will be observed that the B or ring wire is connected to one coil of relay R_4, which in turn is connected to brush *b* of the interrupter. Segments marked *a* which are permanently connected to the generator in the manner shown take one second to pass this brush, while segments marked *s* which are permanently connected to the 40 v. common battery take two seconds to pass. Generator currents, therefore, only circulate in the subscriber's circuit (*viâ* condenser and bell) when segments *a*



27.—Tripping Relay.



28.—500ω Ringing Control Relay.

are passing brush *b*. The reason for connecting segments *s to* the common battery will be mentioned presently.

It will be remembered that the retaining circuit for relay R_3 is *viâ* its own springs and the springs of tripping relay R_4. Relay R_4 is of special construction, the core having a copper jacket, over which the coils are wound and a heavy copper collar at the end nearest to the air-gap. It is therefore insensitive to alternating ringing currents and is not affected by the displacement currents which operate the subscriber's bell. When, however, the receiver at the subscriber's station is raised the bell and condenser at that station are shunted by the transmitter and 17ω winding of the induction coil. The impedance of the generator circuit is considerably reduced in consequence, and the alternating current is now of sufficient strength to energise relay R_4, the springs of which disconnect the retaining circuit for relay R_3. The latter is released, its own springs also disconnecting the retaining circuit, and the subscriber's line is transferred from the ringing circuit to the junction circuit which

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connects at A' and B'. Segments s are joined to the common battery in order that relay R_4 may "trip" the operation of relay R_3 in the manner described above if the subscriber happens to reply during the non-ringing interval. Unless this is provided for it would be possible for the subscriber to take up the receiver during the interval in question and place it to his ear just in time to receive the full benefit of the heavy induced current in the 26^{ω} winding, which would be set up at the commencement of the ringing period.

One or two points of incidental interest should perhaps be mentioned before leaving **26**. As a check against the possibility of the subscriber being called to the telephone before the junction has been taken at the outgoing end, the circuit for relay R_3 is not closed by bringing x and y together unless relay R_1 is energised, the operation being dependent upon the presence of the calling plug in the jack at A (Plate 8).

The retaining circuit of relay R_3 being *viâ* the springs of R_2, it is not possible to lock relay R_3 before the junction plug is in the jack of the circuit required. The retaining circuit of relay R_3 is also dependent upon the speaking key being in its normal position. If this key is thrown while the ringing circuit is connected to the subscriber's circuit relay R_3 is automatically released.

Referring again to the junction it will be noticed that each ringing-button for party-line service has control of six key-springs, which, when the button is depressed, select the type of ringing current required for application to the subscriber's circuit by relay R_3. Osram resistance lamps are inserted for protective purposes between the positive and negative pulsation brushes of the generator and the machine ringing key. Party-line ringing, as well as ringing for ordinary lines, is intercepted by interrupters so as to provide one second ringing period and two seconds' interval. These interrupters are inserted between the generator and the resistance lamps and are identical in construction and wiring to that shown in **26**, except that ring c is connected to the positive or negative pulsation brush, as the case may be, instead of to the alternations brush. In ringing party-line subscribers the resistance lamp is connected direct to one wire of the subscriber's circuit, the other wire being connected to coil b of the tripping relay and earth. When, therefore, a party-line subscriber responds to a call, coil b of this relay is energised, breaking the retaining circuit for relay R_3 and thereby automatically connecting the junction to the subscriber's line for speaking purposes.

Junction Transmission and Clearing Signals.

The speaking circuit between subscriber and subscriber *viâ* junction is also shown in Plate 8.

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This diagram includes the connections which provide for clearing signals. The speaking or transmission circuit is indicated by thick lines. For transmission purposes the junction and the called subscriber's circuit are placed in inductive relationship to each other by the insertion of the repeating coil at *B*.

In accordance with modern telephone practice the A operator is provided with double supervision, lamp *L* being controlled by the subscriber originating and lamp L_1 by the subscriber receiving the call. Lamp L_2 at *B* is controlled by the A operator.

During conversation all the relays shown in the figure, with the exception of relay R_3, are energised. When the subscribers replace their receivers, lamps *L* and L_1 at the A operator's position glow, announcing the termination of the conversation to that operator. Just how this comes about is not difficult to follow. The automatic switch of the subscriber originating the call disconnects the circuit for relay *S* when the receiver is replaced, causing lamp *L* to glow by being connected across the 400$^{\omega}$ resistance. When the receiver is replaced at *B* the automatic switch disconnects relay *R*. This is followed by the disconnection of the 27$^{\omega}$ winding of relay R_1. The latter relay is not released as the 12,000$^{\omega}$ winding now becomes operative. The resistance in series with relay S_1, however, has been increased to such an extent that the current flowing through its coils is not sufficient to keep it energised. Lamp L_1, therefore, also glows.

The A operator will now depress the meter key (shown in **11**) and withdraw the calling and answering plugs from the jacks into which they are inserted, disconnecting the circuit at points *P* and *Q* (Plate 8). The removal of the calling plug from the outgoing junction jack disconnects relay R_1. The springs of the latter assume their normal condition, closing the circuit of lamp L_2. Seeing the glow, the B operator removes the junction plug from the called subscriber's multiple jack, disconnecting relay R_2 and darkening the lamp.

Incoming Junctions from Trunk Exchange.

The upper diagram in Plate 9 is that of an incoming junction from the Trunk Exchange. It only differs from the junction incoming from a common battery exchange in two particulars: first, the connections of relay R_1, and second, the superposition of a tone upon the direct current which operates relay R_2. The first difference mentioned is necessary in order to meet the requirements of the cord circuit at the trunk exchange, the supervisory relay *T* being operated by a current which flows over the two wires of the junction in parallel and through the 27$^{\omega}$ winding of relay R_1.

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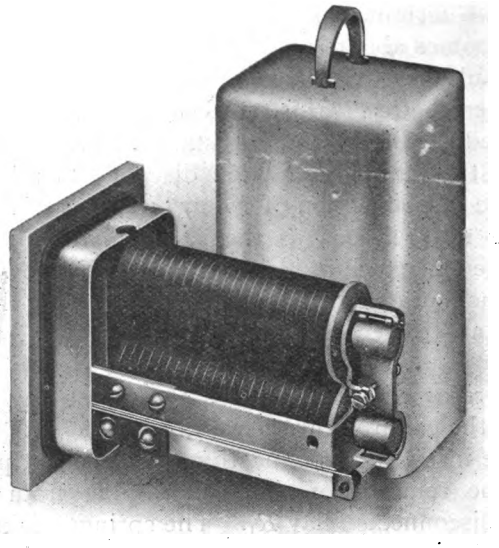
When the required subscriber responds to the call, relay R is operated, disconnecting the 27$^{\omega}$ winding of relay R_1. As in the case of the common battery junction, the 12,000$^{\omega}$ winding of relay R_1 becomes operative and prevents the release of this relay; 17000$^{\omega}$ has been added to the resistance in series with relay T, however, and the current in the winding of this relay is diminished to releasing point.

When a trunk call arrives for a subscriber who is engaged locally, the engaged circuit is entered with the view of ascertaining whether the required subscriber will receive the trunk call. This procedure, however, is not followed when the subscriber is already engaged in



29.—Junction Relay 12,000$^{\omega}$ and 27$^{\omega}$.

a trunk conversation, and at exchanges where two or more B operators have to deal with calls from the Trunk Exchange, such as is the case in this exchange, a tone is superposed upon the cut-off relay circuit in order that the trunk junction operators when testing shall be made aware of the circumstances and refrain from disturbing the subscriber. The method of applying the tone is shown in the diagram (Plate 9). The current in the primary winding of the trunk tone transformer is interrupted 133 times per second, and the low resistance secondary winding is connected to relay R_2.

Ringing Junctions.

The two junction circuits just described are arranged for order-wire working. Ringing junctions differ only in that 10$^{\omega}$ relays are

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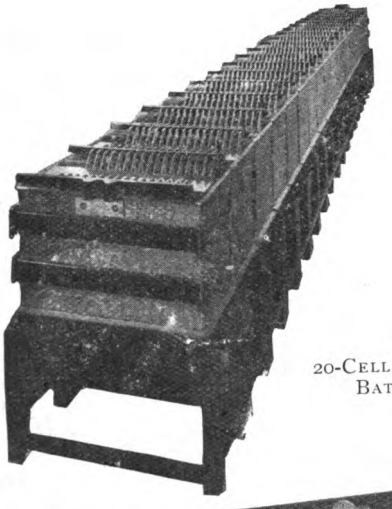
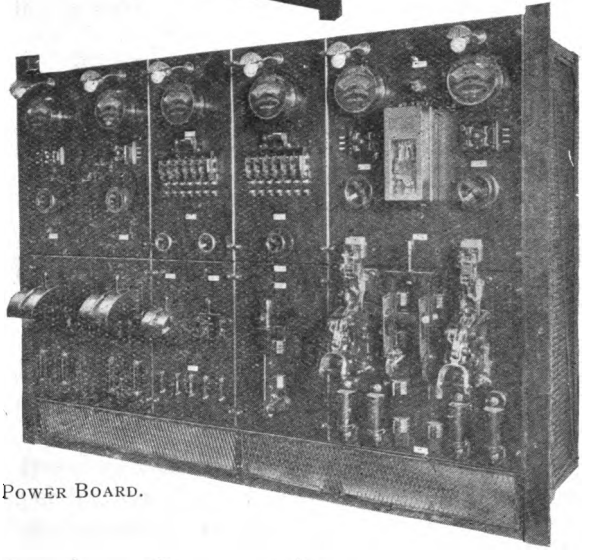
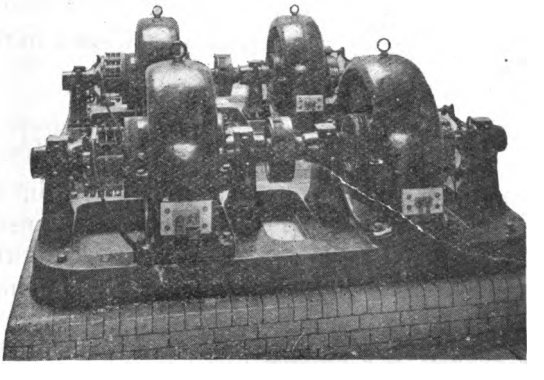


20-Cell Common Battery.



Power Board.



Motor-Generators.

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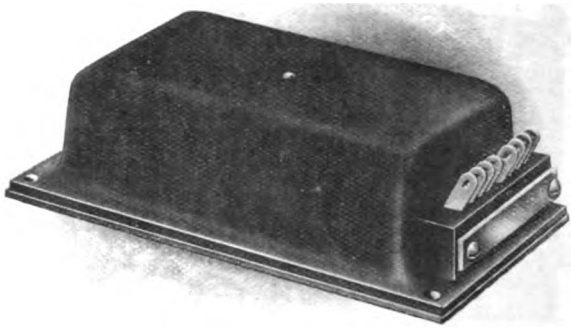
added as shown in Plate 7. These relays are so placed as to be responsive to a call from the distant exchange.

Two-way Junctions.

A number of two-way junctions will be required between the central exchange and some of the Department's minor exchanges. The circuit connections for these are at the foot of Plate 9. As its title implies, this circuit may be used either as an outgoing or as an incoming junction. When used as an outgoing junction the 50ω relay cuts off the incoming section, and when used in the reverse direction relay R_1 disconnects the 50ω relay and applies an engaged test voltage to the sockets of the outgoing junction multiple jacks. To



30.—Repeating Coil.

call the minor exchange it is merely necessary to insert the calling plug into the outgoing junction jack, while central is called by the insertion of a calling plug into the jack at the minor exchange.

The 12,000ω and 27ω relay and repeating coil used in the junction circuits are illustrated in **29** and **30** respectively.

High Resistance Subscribers' Circuits.

Several subscribers' circuits to be terminated in the central exchange have line resistances too high for efficient transmission and signalling by the ordinary methods. For such circuits the arrangements shown in Plate 10 will be employed. Signalling from the subscriber's station is automatic throughout. The removal of the receiver at the subscriber's station places the coils of that receiver and the secondary winding of the induction coil across the *A* and *B* wires of the circuit. Relay R_1 is operated, connecting the sub-

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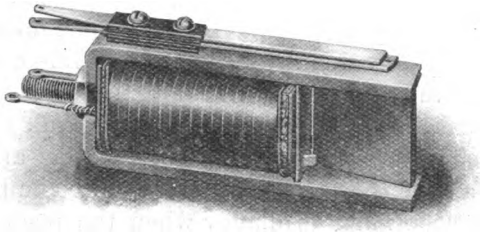
scriber's circuit to the exchange through condensers and providing a circuit for the line relay *viâ* the 600$^{\omega}$ retardation coil. The clearing signal is given, on the replacement of the receiver, by relay R_1. In the case of a call from the exchange, the ringing generator when applied will operate the slow-acting alternating-current relay R_2, which in turn actuates relay R, the springs of the latter applying the ringing generator to the subscriber's line. The alternating-current relay is shown in **31**. The armature consists of a rectangular plate about one-eighth of an inch thick pivoted vertically between the two core extensions, the pivot being close to the ends of these extensions. Fixed upon the upper edge of the armature, near the pivot, and passing through a hole in the upper core extension, is an ebonite cam which engages with the end of the long spring. The pressure of this spring upon the cam keeps the armature in the position shown. When a current circulates in the winding, the armature is



31.—Alternating or Pulsating Current Relay.

drawn into line with the relay core, and the longer spring is forced by the action of the cam into contact with the shorter one above. Between the ringing intervals the removal of the receiver will close the circuit for relay R_1, and the supervisory relay will be energised by a current which flows *viâ* the 600$^{\omega}$ retardation coil. If the call is from the junction-board the 600$^{\omega}$ coil provides a path for an operating current through the tripping relay.

Record Circuits.

The existing types of record circuits are not suitable for a common battery exchange with double-wound supervisory relays, and it has therefore been necessary to introduce the circuit shown at the foot of Plate 10. To call the Trunk Exchange the local A operator merely inserts the calling plug into the record circuit jack, actuating R_1. To answer the call the record transfer operator inserts the plug of a disengaged record table circuit, an action which connects to the record table circuit and closes the circuit of relay R_2; R_1 is disconnected and the calling lamp extinguished. The 300$^{\omega}$ retardation coil gives a loop for the supervisory relay at the

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local exchange so that the lamp at this exchange also darkens. When the plug of the record table circuit is removed, springs *a* and *b* make before *c* and *d* break, so that relay R_2 remains energised until the circuit is cleared by the operator at the local exchange. R_2 remaining energised prevents the calling lamp from glowing during the interval between the withdrawal of the plug at the Trunk Exchange and the removal of the calling plug at Central.

Switchroom Testing Sets.

That small but useful tester commonly known amongst inspectors in C.B. exchanges as the " 3-lamp set," had to be modified before it could be used upon this equipment. A diagram of the set as altered is given in Plate 11. Thirty-six-volt lamps are used for the tip, ring, and sleeve circuits. The enumeration of all possible faults and their indications upon the tester would comprise an article in itself. Two faults among the many which may arise might, however, be mentioned. First, " tip " conductor of subscriber's line circuit to earth; second, two " sleeve conductors " in contact.

In the first case the presence of an earth fault on the tip conductor would reduce the sensitiveness of the line and supervisory relays, also unbalance the transmission circuit. The tip lamp of the set glows with exceptional brilliancy when the peg of the tester is inserted into the jack of the faulty line. In the majority of cases the subsequent depression of key *S* will not cause the tip-lamp of the set to darken. In the minority of cases the fault will be between the cut-off relay springs and the line relay coil, and under these conditions the sensitiveness of the line relay is reduced, but not that of the supervisory relay: the insertion of the peg causes the tip-lamp to glow very brilliantly as before, but the depression of key *S* will bring about the darkening of the tip-lamp.

The second fault rarely occurs in practice, but it is of so serious a nature that special precautions have been made with the view to its detection. When the fault is in existence, the cut-off relays of both circuits may be operated by the insertion of a plug in the jack of one, so that if the subscriber of the second line raised his receiver to call the exchange whilst the first line was engaged, he would have to wait until the first line became disengaged before his call could be received. The insertion of a plug into the jack of one line also applies the engaged test to both.

In order to bring a fault of this description to light, the resistance in series with the sleeve key of the tester is of such a value that the depression of this key will not operate either cut-off relay when two are in multiple, but will operate one cut-off relay by itself.

The adjustments of the line, cut-off, and supervisory relays are

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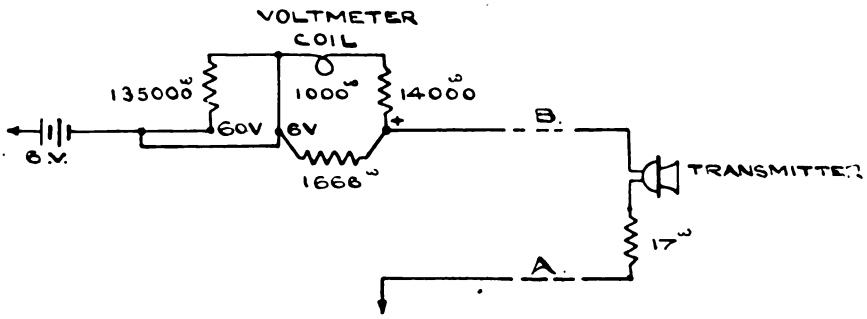
verified by the use of the tester shown in the lower diagram of Plate 11. A description of this tester is not necessary, however, as the notes at the foot of the diagram will be found to render it self-explanatory.

Testing Arrangements. Wire Chief's Desk.

Plate 12 shows the testing circuit provided upon the Wire Chief's desk. The functions of the keys are identical with those of the keys upon similar desks in the latest C.B. exchanges of the Department. Owing to the fact that the voltage of the common battery while under charge may reach as high a figure as 52 volts, it has been necessary to provide the voltmeter with a 60-volt scale. By the manipulation of three keys—Nos. 16, 17, and 18—the resistance of the voltmeter can be given any of three values, viz. 1500ω, 15,000ω, or 150,000ω. A 6-volt battery is used with the first two values, and



32.—Measuring Resistance of Subscriber's Loop.

a 60-volt battery with the last. With this arrangement resistances varying between 12 ohms and 17,000,000 ohms can be measured with a fair degree of accuracy. The application of this facility cannot better be illustrated than by describing a few typical tests which may have to be made in practice.

(*a*) To ascertain the resistance of a subscriber's loop with the receiver off:

The testing peg will be inserted into the jack of a "test and plugging-up" circuit. To this circuit the subscriber's loop will be connected and keys 8, 16, 17 and 18 thrown, establishing the connections shown in **32**. The deflections of the voltmeter are proportional to the current flowing in the voltmeter coil, and ·4 m.a. gives a full scale deflection. The resistance of the loop R may therefore be quickly ascertained by applying the following formula:

$$R = V \frac{T-D}{D}$$

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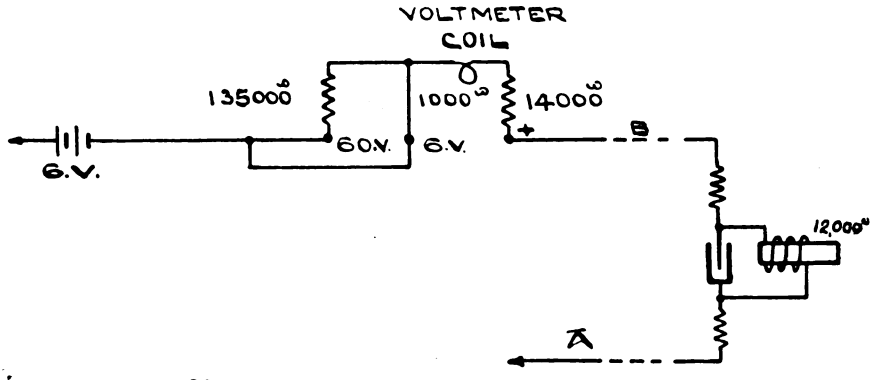
Where V = resistance value of the voltmeter combination (in this case 1500ω),

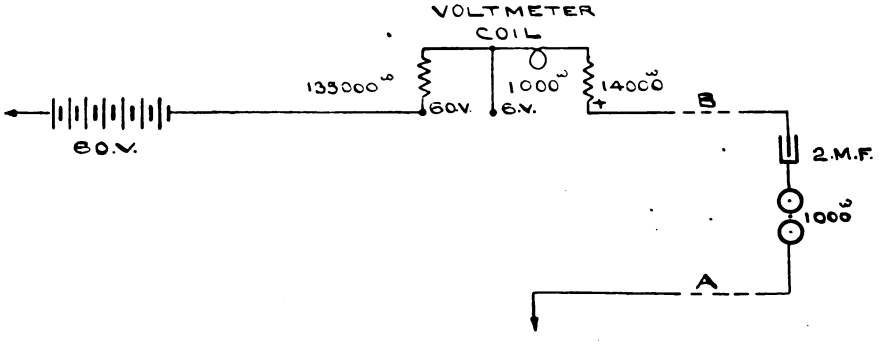
T = total number of divisions on voltmeter scale,

D = deflection produced by current, in divisions.

Two scales are provided, 0 to 6 and 0 to 60, and either may be chosen. The 0 to 60 scale, however, will be more accurate, although for rough tests the 0 to 6 scale may be found more convenient.



33.—Measuring Resistance of Junction Loop.



34.—Measuring Insulation Resistance (wire to wire).

Taking the 0 to 60 scale and assuming that the deflection produced in this case is 40 divisions, then—

$$R = 1500 \times \frac{60-40}{40} = 750^{\omega}.$$

(*b*) To verify the resistance of an outgoing junction loop with 12,000ω relay at distant point:

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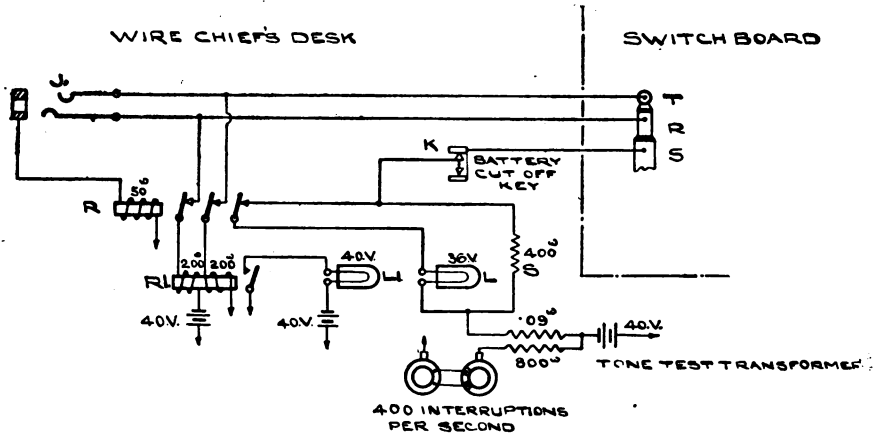
For the best results the resistance of the voltmeter combination should be as near as possible equal to that of the resistance to be determined. In this case, therefore, the 15,000ω combination would be used, and the conditions will be the same as in case (*a*) except that the voltmeter shunt key No. 18 will not be thrown. The connections of the voltmeter are given in **33**. Assuming that a deflection of 32·5 divisions is obtained, then—

$$R = 15{,}000 \times \frac{60-32{\cdot}5}{32{\cdot}5} = 12{,}700^{\omega} \text{ approx.},$$

or 12,000ω for the relay and 700ω for the remainder of the circuit.

(*c*) To ascertain the insulation resistance between two wires of a subscriber's circuit:

For this test the subscriber's receiver will be on its rest and two



35.—Test and Plugging-up Circuit.

only of the four keys referred to in (*a*) will be thrown, viz. Nos. 8 and 16. [Under these conditions (34) the volt-meter combination has a resistance of 150,000ω, and the testing battery a voltage of 60. A deflection of 5 divisions would indicate an insulation resistance of—

$$150{,}000 \times \frac{60-5}{5} = 1{\cdot}65 \text{ megohms}.$$

The use of the formula for each test is, however, avoided by the preparation of a table connecting the 120 readable deflections with corresponding resistance values, when the volt-meter combination has a resistance of 1500ω. For the 15,000ω or 150,000ω combinations the resistance under measurement would, for the deflection observed, be 10 or 100 times that given in the table.

Reference has been made to a "test and plugging-up" circuit. Forty such circuits are provided—twenty for each position of the

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Wire Chief's desk. As in the case of the Department's existing exchanges, these circuits are the means whereby any subscriber's circuit may be connected to the Wire Chief's desk for test. **35** is an explanatory diagram of a test and plugging-up circuit. It will be noticed that the circuit terminates in a plug at the switchboard. Here the subscriber's multiple is available and the plug can be inserted into a multiple jack of any subscriber's circuit. The insertion of the plug causes the subscriber's cut-off relay to operate, disconnecting the line relay, and connecting the *A* and *B* wires of the subscriber's circuit to conductors *T* and *R* of the plug. Lamp *L* at the desk glows, advising the testing officer of the connection, and the subsequent insertion of the testing plug into jack *J* will energise relay *R*, taking the windings of relay R_1 from the circuit and disconnecting lamp *L*. The subscriber's line, clear of any apparatus which might affect the results of the tests, is now connected to the testing circuit. By throwing key *K* in **35** and key No. 14 in Plate 12, the testing officer can verify the operation of the subscriber's line and cut-off relays. During the existence of the fault the subscriber's circuit will remain "plugged up" at the switchboard, an arrangement which removes from the switchboard "permanent glows" caused by such faults as "*B* wire to earth," "receiver off," or "*A* and *B* wires in contact." After the removal of the testing plug, however, relay R_1 would be brought in circuit, and the glowing of lamp L_1 keeps the testing officer aware of the existence of the fault. An earth fault upon the *A* wire of a circuit would not be indicated in this way, and to provide for this class of fault the tip and ring conductors of a few of the test and plugging-up cords may be crossed at the switchboard cord shelf.

Lamp *L* and resistance spool *S* are connected to the common battery *viâ* the secondary winding of a tone test transformer, in order that an operator testing a "plugged-up" circuit may be apprised of its condition by the tone which accompanies the click in her receiver.

Switchroom Desk Equipment.

The switchroom desks were referred to when the floor plan was under review, but the facilities provided by the equipment upon these desks are so many and varied in character as to call for more than a remark *en passant*; indeed, the desk equipment in the switchroom of a modern exchange may almost be regarded as a small exchange in itself.

The information desk is comprised of two sections of two positions each, and is designed in such a way that additional sections may be installed when extension is necessary. Particulars of the special circuits which will be attended to by the information operators are given below:

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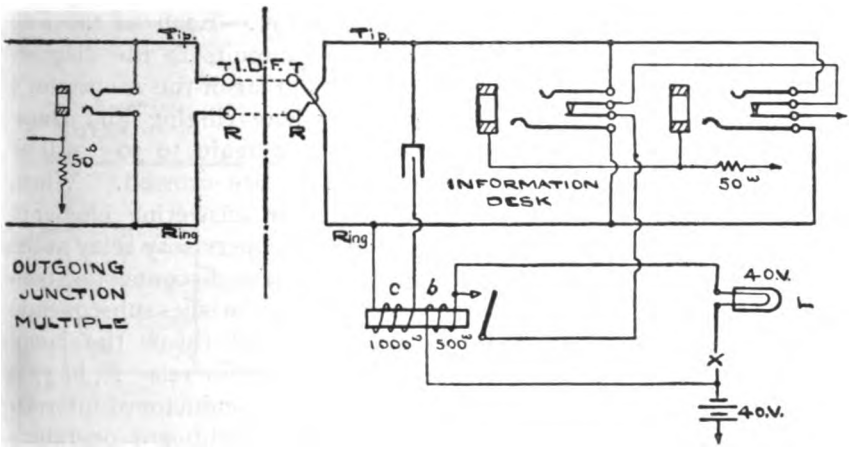
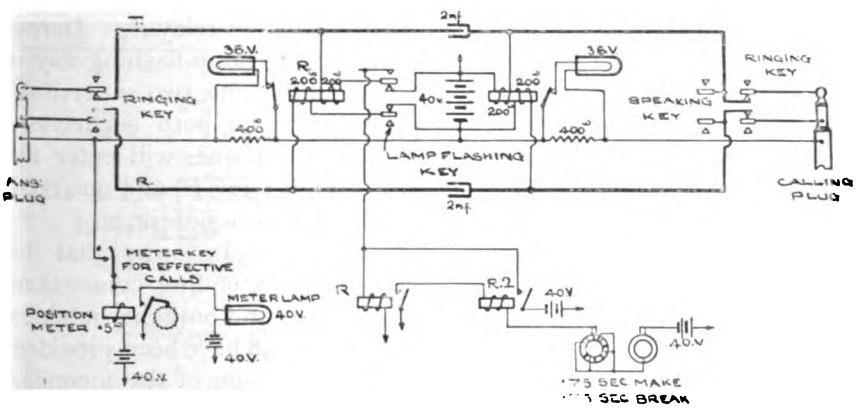
INCOMING LINE CIRCUITS FROM SWITCHBOARD.—By means of these circuits the switchboard operators are enabled either themselves to pass inquiries or complaints to the information operator or to extend subscribers to the information operator for direct communi-



36.—INFORMATION DESK, INCOMING LINE FROM SWITCHBOARD.



37.—INFORMATION DESK CORD CIRCUIT.

cation, the latter course being preferable in that the switchboard operator experiences minimum obstruction in handling routine calls.

The connections are given in **36**. The circuits are led to the intermediate distribution frame, where they can be cross-connected to any spare outgoing junction circuit. To call the information operator the switchboard operator will insert the plug into the junction jack and throw the ringing key. Winding *c* of relay *R* is

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energised and tends to set the relay armature in vibration. This is prevented, however, by the action of winding *b*, the circuit of which is closed as soon as the armature is attracted to the core. Lamp *L* glows, being in multiple with *b*. The information operator, in reply, will insert the answering plug of a disengaged pair of cords, breaking the circuit for both winding *b* and lamp *L*.

INFORMATION OPERATOR'S CORD CIRCUIT.—Each of the four positions has been equipped with 8-cord circuits to the diagram shown in **37**. The diagram only differs from that of the A operator's cord circuit upon the answering side, where ringing and lamp-flashing keys have been provided. Referring again to **36** it will be observed that the tip and ring conductors are crossed. When, therefore, the information operator inserts an answering plug into one of the jacks shown to the right in **36** the supervisory relay at the switchboard and that marked *R* in **37** will operate, disconnecting both supervisory lamps. If the information operator wishes subsequently to bring the A operator into circuit, she will throw the lamp-flashing key of the cord in use. The circuit for relay R_1 in **37** is immediately closed *viâ* winding of relay *R*, tip conductor of information operator's cord, and ring conductor of switchboard operator's cord. This circuit, therefore, includes the supervisory relay *R* at the information desk and the supervisory relay in the cord at the switchboard. All these relays are energised. Another relay, R_2, in series with an interrupter is placed in the local circuit of relay R_1. During each "make" period which occurs while the lamp-flashing key is thrown, relay R_2 is energised, short-circuiting the two supervisory relays, and producing a ·75 second glow upon both supervisory lamps. The switchboard operator seeing the flashes will enter the circuit by throwing the speaking key. One relay R_1 and one relay R_2 are provided for each position of the information desk.

OUTGOING LINES TO THE SWITCHBOARD.—In order that the information operator may have facilities for extending connections from the information desk to the subscriber's and outgoing junction multiples, twenty circuits of the type shown in **38** have been provided. These circuits are operated by order-wire to one of the incoming junction positions. The B operator has merely to test and connect to the subscriber's or outgoing junction circuit required. In the case of a connection to a subscriber's circuit the information operator will ring the subscriber. The subscriber's clearing signal is received by the information operator who thereupon removes the calling plug, disconnecting relay *R* and closing the circuit of lamp *L* (**38**). The B operator then takes down the connection in the multiple.

INFORMATION OPERATOR'S TELEPHONE CIRCUIT.—The two positions of one section have telephone circuits identical with

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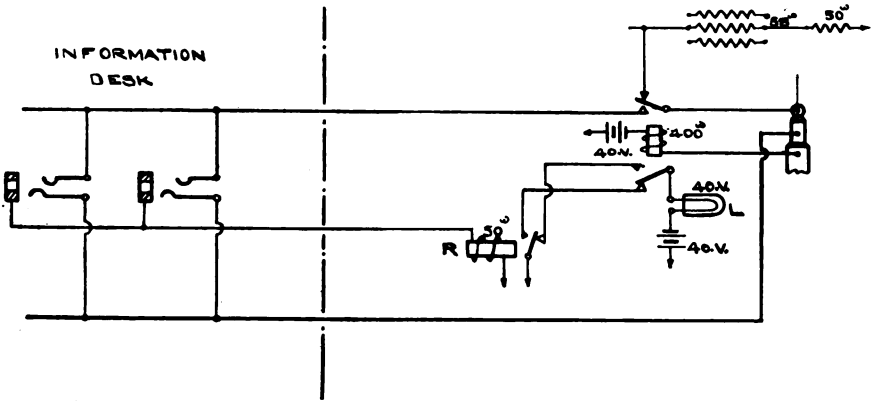
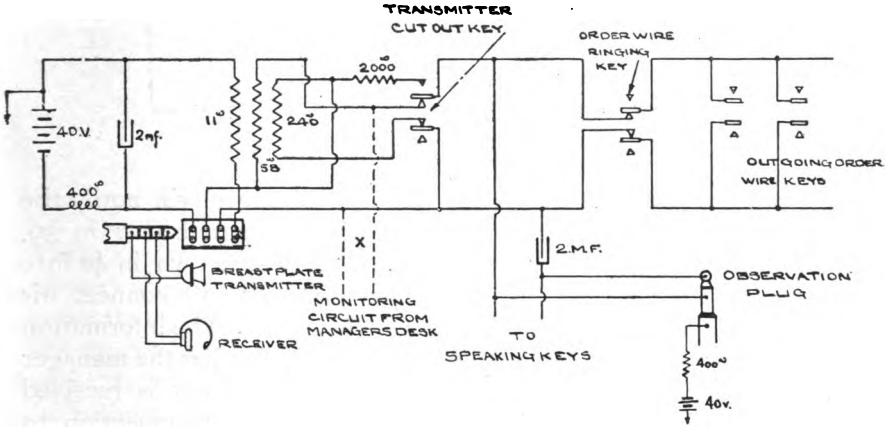
those for the A operator. The other section, however, is provided with monitoring circuits to the *A* positions, *B* positions, and outgoing order-wires, and for use in connection with these circuits transmitter cut-out keys and observation plugs are fitted. The method of associating these items with the telephone circuit is shown in **39**. To connect to a monitoring circuit, the information operator, having all other keys upon the position normal, will throw



38.—Information Desk, Outgoing Lines to Switchboard.



39.—Information Operator's Telephone Circuit.

the transmitter cut-out key and insert the observation plug into the jack of the monitoring circuit required. She will then hear the working upon the position or order-wire under observation. If it is necessary to speak the transmitter cut-out key will be released. The transmitter circuit is not actually disconnected by the cut-out key, as in older circuits. The same purpose is fulfilled by opening the circuits for the 58ω and 240ω windings of the induction coil, a

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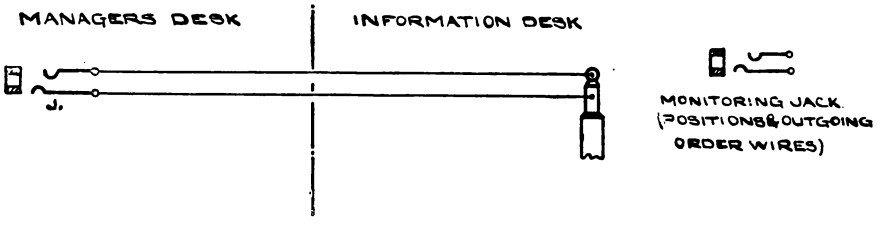
method which avoids the severe clicks in the operator's receiver, following disconnections or re-connections of the transmitter circuit. In order, however, that the transmission efficiency of the position under observation shall not be affected by the removal of the induction coil at the observing point, the throwing of the cut-out key introduces a 2000$^{\omega}$ non-inductive resistance in series with the receiver and condenser.

MONITORING CIRCUITS.—The manager is provided with monitoring circuits to the chief operator's, assistant chief operator's, and information operator's telephone circuits, but not to the switchboard positions or outgoing order-wires, and in order that he may be able to observe the working at any of the last-mentioned points a special circuit is provided between his desk and that section of the information board upon which the monitoring circuits to these points terminate. Particulars of this circuit are given in **40**. To obtain a connection to any switch-



40.—MONITORING CIRCUIT.

board position or outgoing order-wire the manager will notify the information operator over a direct circuit terminated at x in **39**. The information operator will then insert the plug shown in **40** into the monitoring jack required, and the manager will connect his observation plug to the jack marked J in this figure. The information operator may allow the connection to remain until either the manager asks for a connection to another position or a request is received from the chief operator or assistant chief operator for connection to the same point. Similar facilities are provided between the information desk and the chief operator's and assistant chief operator's desks. The assistant chief operator will, however, only take advantage of the facilities when she wishes to observe the working upon an outgoing order-wire, as the monitoring circuits to the positions are represented upon her desk as well as upon the information desk.

OFFICIAL CIRCUITS.—These circuits are provided to afford intercommunication facilities between the desks themselves and between the desks and the switchboard. At the manager's, chief operator's,

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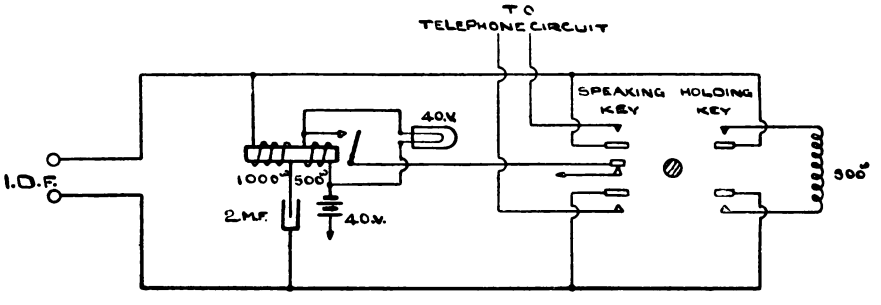
and assistant chief operator's desks they terminate upon 3-position keys in the manner indicated by **41**. Calling is by generator, with a retaining-lamp circuit, which is disconnected by the speaking-key when thrown in response to a call. It may be that the call will involve an inquiry to another point, or that other more important business will suddenly present itself, in which case the connection may be removed from the desk telephone circuit and retained so far as the calling point is concerned by throwing the holding key, which places a 500$^{\omega}$ coil across the circuit. The official circuits are led to the I.D.F., where they can be cross-connected to any of the switch-room desks or to a subscriber's line circuit. At the information desk the connections of the official circuits are identical with those shown to the right of the chain-dotted line in **36**.

TELEPHONE CIRCUIT FOR THE MANAGER, CHIEF OPERATOR, OR ASSISTANT CHIEF OPERATOR.—This circuit, given in **42**, resembles



41.—OFFICIAL CIRCUIT.

the telephone circuit for the information operator shown in **39**. There are, however, three important variations. A retardation coil of 500$^{\omega}$ resistance is normally across the tip and ring conductors, in order that the throwing of the speaking key shall close the circuit of the supervisory relay at the calling point. This coil is disconnected when the transmitter cut-out key is thrown. A ringing-key provides for calling upon circuits to other desks, and instead of the head-gear receiver and breast-plate transmitter a pedestal telephone instrument is provided.

SERVICE OBSERVATION CIRCUITS. — The service observation circuits are provided for the purpose of observing the service given upon subscribers' lines. The circuits are placed under the control of the assistant chief operator, upon whose desk an equipment for ten circuits is provided. They are terminated upon the local side of the I.D.F., where they can be cross-connected to any subscriber's circuit. When connected to a subscriber's circuit the apparatus

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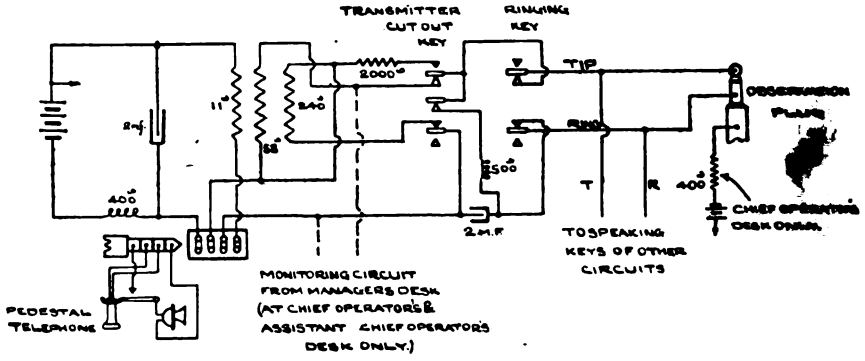
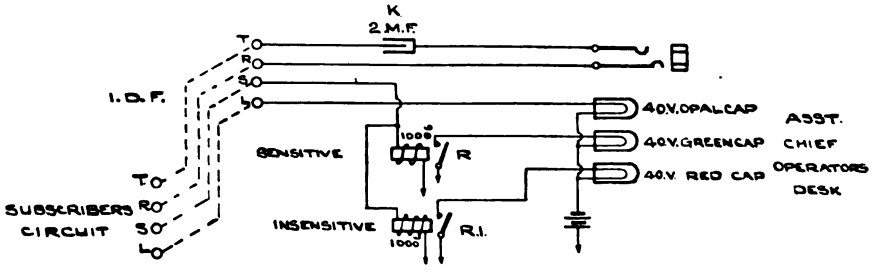
included is such as to indicate to the assistant chief operator (*a*) the presence of a plug in one of the subscriber's circuit jacks, (*b*) the removal of the subscriber's receiver from its rest when calling the exchange, (*c*) the depression of the meter-key by the switchboard operator at the conclusion of the conversation. 43 gives the connections of the apparatus. Condition (*a*) is met by placing a sensitive relay (*R*) in multiple with the subscriber's cut-off relay. The insertion of a switchboard plug into any multiple jack or into the answering jack will operate both the subscriber's cut-off relay and



42.—Telephone Circuit. Manager, Chief Operator, Assistant Chief Operator.



43.—Service Observation Circuit.

the sensitive relay of the observation circuit. The lamp with a green cap glows. The removal of the receiver to call the exchange operates the line relay closing the circuit for the line-lamp. The lamp with an opal cap, shown in 43, being connected in multiple with the line-lamp, also glows. Finally, the insensitive relay marked R_1 does not operate until the meter-key is depressed by the A operator, when the lamp with a red cap glows.

It may occasionally happen that the assistant chief operator enters an observation circuit when the subscriber is being called from the *B* board. To prevent the premature operation of the tripping

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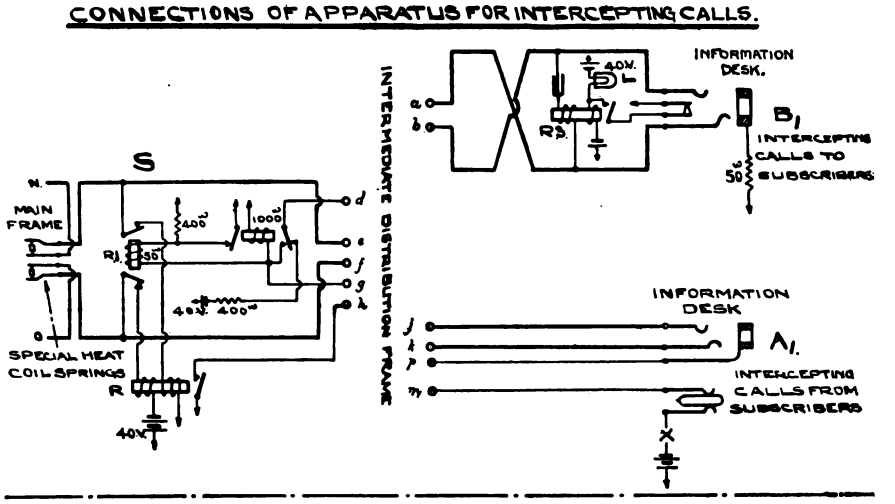
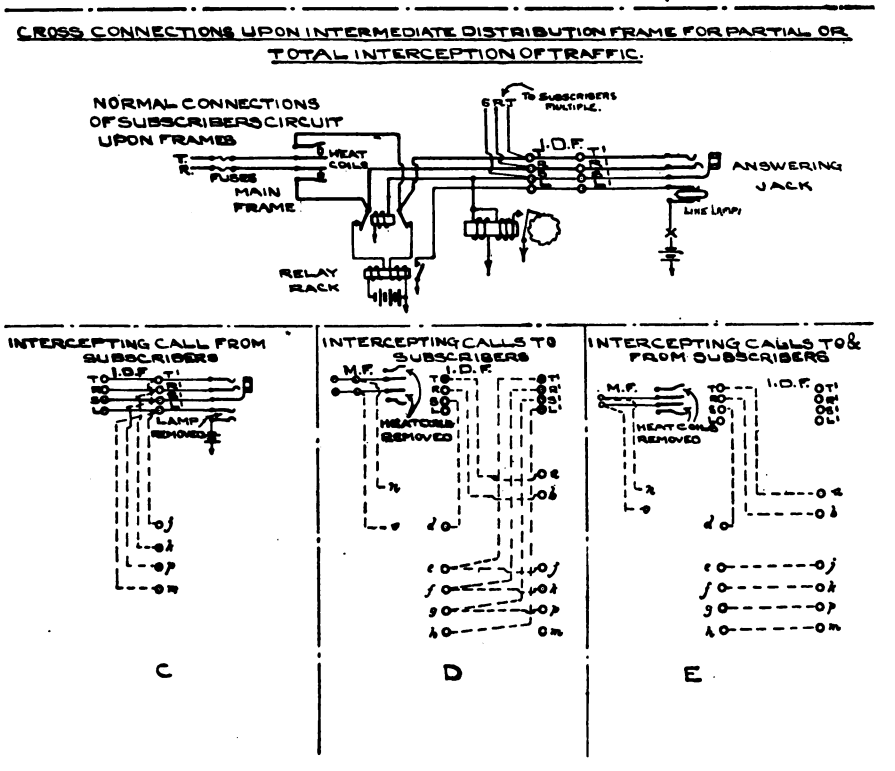
relay upon the incoming junction, condenser K of 2-mf. capacity is inserted in the tip conductor of the service observation circuit.





INTERCEPTING CIRCUITS.—These circuits are provided to meet the special cases where it becomes necessary to intercept the traffic

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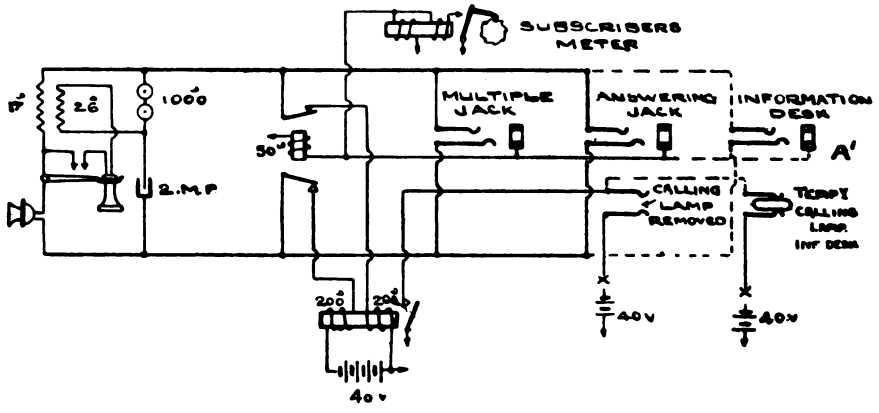
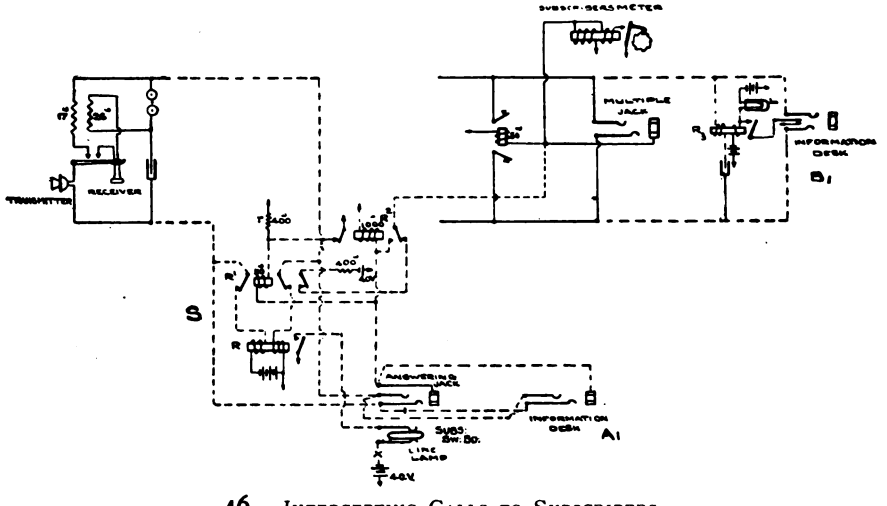
upon a subscriber's circuit in either or both directions. An intercepting circuit may be regarded as having apparatus in three divisions. The divisions are marked A_1, B_1, and S in 44. Intercepted calls to and from subscribers are received at B_1 and A_1 respectively, which points are located at the information desk.

To intercept calls from a subscriber the answering lamp will be



45.—Intercepting Calls from Subscriber.



46.—Intercepting Calls to Subscribers.

removed from its socket and the T', R', S' and L' terminals upon the intermediate frame will be teed to terminals j, k, p and m of division A_1, as shown at C in 44. When this has been done the subscriber's circuit will take the form shown in 45, and the information operator receives all calls originated by the subscriber. As will have been observed in 37 the information operator is provided with

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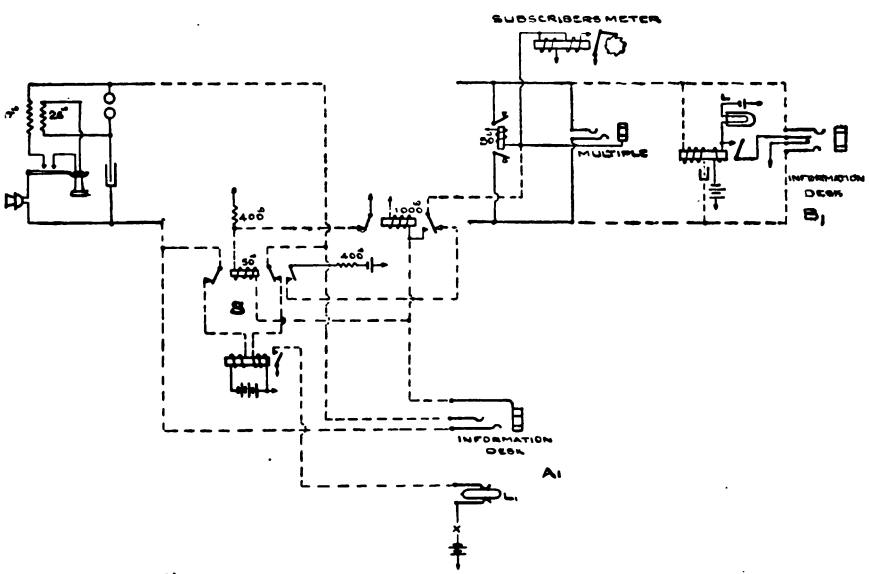
a meter circuit, so that effective calls can be recorded upon the subscribers' meter.

The arrangements for intercepting calls to a subscriber are a little more involved. In this case the heat coils are removed and the cross connections shown at *D* in 44 are established. The connections of the subscriber's circuit are then as given in **46.** By the agency of relay *R* in division *S* calls from the subscriber are received at the switchboard. The insertion of the answering plug closes the circuit of relay R_1, which not only disconnects relay *R*, but connects a test voltage to the subscriber's multiple jacks. Relay R_2 is not energised until the *A* operator depresses the meter key at the conclusion of the conversation. When actuated, this relay extends the high voltage



47.—Intercepting Calls to and from Subscribers.

applied by the meter key to the subscriber's meter, the operation of which reduces the resistance of the circuit sufficiently to cause the *A* operators' position meter also to register the call and light the meter lamp. Another function of relay R_2 is to remove the short-circuit about resistance *r* in order to prevent the premature operation of the switch-board operator's position meter.

Calls for the subscriber are announced by the glowing of lamp *L* at B_1. To reply, the information operator inserts the answering plug of a disengaged cord, disconnecting the retaining circuit for relay R_3 and darkening lamp *L*. If the call is intended for this subscriber the information operator will proceed to establish connection by inserting the calling plug into the jack at A_1 and ringing the sub-

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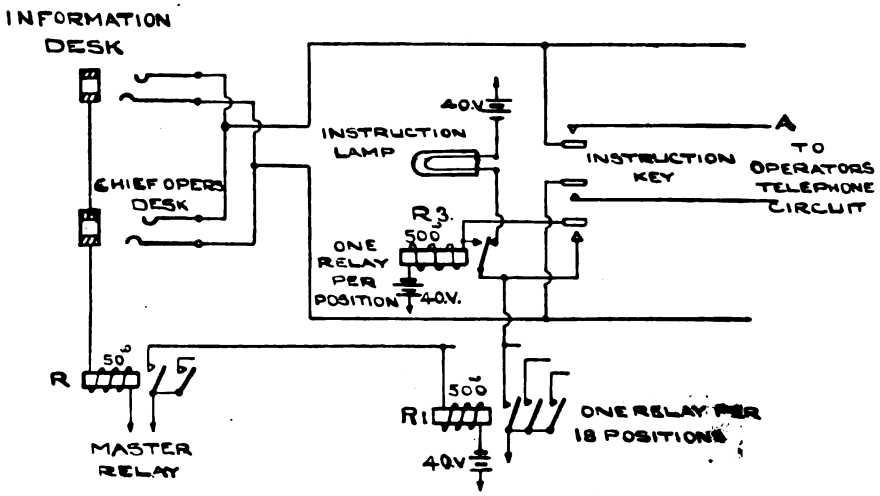
scriber. The clearing signal from the subscriber is received at the information desk, and the removal of the answering plug at this point gives a clearing signal to the A operator.

If the call is intended for another subscriber the connection may be extended to the multiple upon the B board by means of one of the circuits given in 38.

Calls to and from a subscriber may be intercepted by removing the heat coils and connecting up as shown at E in 44. The subscriber's line circuit is then arranged as in 47. This differs from 46 only in that the switchboard answering lamp and jack are out of circuit, and lamp L_1 at the information desk is brought into circuit. Calls from the subscriber are received at A_1, and calls to the subscriber at B_1.

One other circuit should perhaps be mentioned, viz. the circuit which gives the information operator and the chief operator the facility for communicating quickly with all the "A" operators. It is named the "instruction circuit." The connections in explanatory form are given in 48. The insertion of an observation plug either at



48.—Instruction Circuit.

the chief operator's or the information desk will close the circuit of the master relay R, operating all subsidiary relays R_1; the instruction lamps, upon all positions, glow. These lamps continue to glow until the A operators give attention by depressing the instruction keys, which are located with the outgoing order-wire keys. When an A operator depresses the instruction key she brings her telephone in circuit, and by means of subsidiary contacts upon the key closes the circuit for relay R_3, disconnecting the instruction lamp. The

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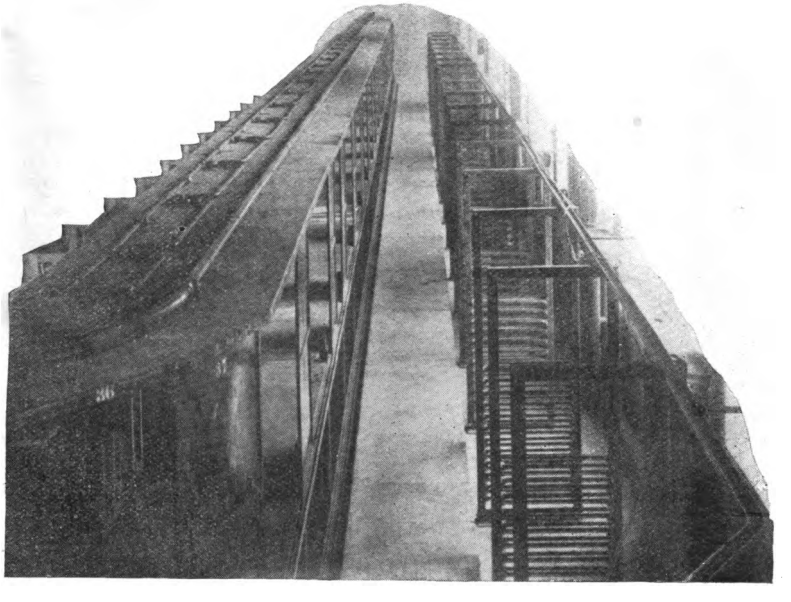
operation of relay R_3 also closes a retaining circuit for its own winding *viâ* earth at relay R_1. When, therefore, the A operator releases the instruction key the lamp does not again glow. Relay R_3 is released when the master relay is disconnected by the removal of the observation plug from the instruction circuit jack.

The supervisors or monitors have each control of nine positions. Each is provided with a telephone circuit, which includes a hand combination set. When not in use this set will be accommodated in a box of suitable dimensions fixed to the aprons of adjacent key-shelves at the centre of the group of positions.

In conclusion, readers will be interested to learn that the whole of the equipment has been manufactured in this country. The manufacturers and installers are the Peel-Conner Telephone Works, Limited, of Salford, to whom the writer is indebted for the loan of blocks illustrating the apparatus and for permission to reproduce an interesting series of photographs showing various portions of the equipment. Owing to the prevalence of fogs in Glasgow much difficulty has been experienced in obtaining clear views of the equipment, and most of the photographs were obtained by the aid of a large mercury vapour lamp. Taken under such adverse circumstances, the photographs reflect great credit on the photographer, Mr. R. Turnbull, of Glasgow.



REAR VIEW OF SUBSCRIBERS' BOARD, SHOWING APPARATUS RACKS.

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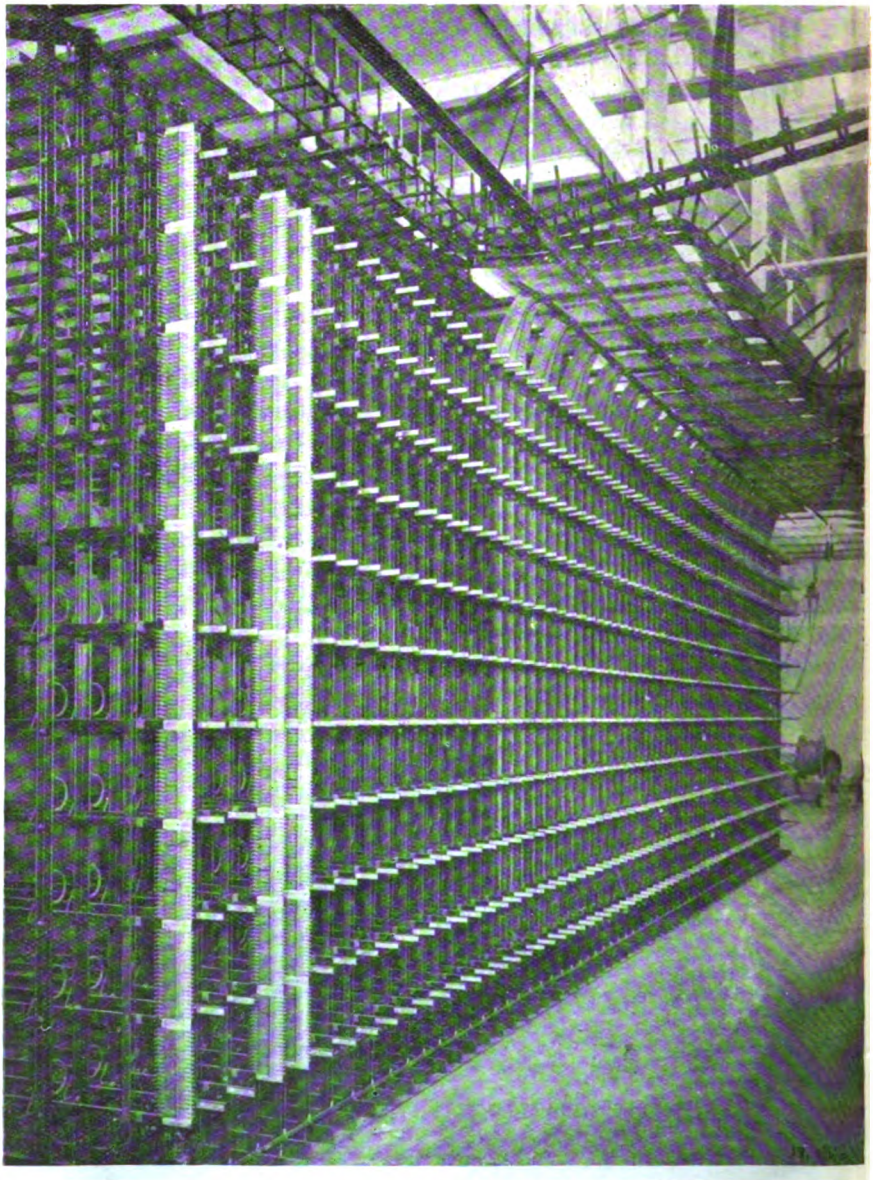

EXCHANGE SIDE OF MAIN DISTRIBUTION FRAME (HEAT COILS AND LIGHTNING PROTECTORS FOR ONLY 600 CIRCUITS SHOWN IN POSITION).

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THE EARLY HISTORY OF WIRELESS TELEGRAPHY.

By J. E. TAYLOR, A.M.I.E.E.

(*Continued from p.* 162.)

EARLY DEVELOPMENTS UNDER THE MARCONI COMPANY.—It will perhaps be sufficiently obvious from the preceding account of the association of the Post Office telegraph department with the very early development of wireless telegraphy (duly set out in official documents) that the abrupt cessation of the work of investigation, as a matter of policy, consequent on the formation of the Wireless Telegraph Syndicate, probably resulted in some retardation of its development in this country. Those of the engineers of the Postal Telegraph Department who had the good fortune to be closely associated with the investigations up to this stage and were undoubtedly directly in the track of those improvements in methods and apparatus which have made the wireless telegraphy of to-day a practicable and reliable method of communication, having acquired sufficient knowledge and experience of the system to guide them into the proper channels of development were abruptly relieved of the work. Meanwhile the investigation had been actively taken up by other administrations in various parts of the world, notably by the German authorities, and by private enterprise in America and elsewhere. Had it not been for this rebuff it is likely that the lead gained in this country, consequent on the initial enterprise of Sir W. Preece, would have been amply maintained. There is good reason to suppose, however, that at about the time of the Dover experiments in September, 1897, at the initiation of which Capt. H. B. Jackson, R.N. (now Rear-Admiral Sir Henry Jackson, K.C.B., F.R.S.) was an interested spectator, the British Admiralty fully woke up to the necessity for investigating and developing the art for use in the Navy, no doubt with considerable success. Otherwise, so far as this country is concerned, the succeeding steps in the development were in the hands of Signor Marconi and his syndicate together with paid professional assistance and the help of members of their own staff after they had acquired the necessary experience and familiarity with the subject.

A slow, step-by-step development ensued, mainly by rule of thumb methods of trial and error. Scientific investigation of the broad general principles does not appear to have been systematically undertaken. Instead of quantitative measurements necessary to arrive at

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a true understanding of the principles involved, attention appears to have been mainly confined to working out details of the apparatus with a very imperfect understanding of the magnitudes of the electrical quantities concerned. The great aim appeared to be to transmit signals over the longest possible distance. Many of the claims and statements made were so obviously overdrawn and untrustworthy that much of the real rate of progression was obscured by a cloud of humbug having for its main object the manipulation of the financial market.

Between the years 1897 and 1899, during which time Post Office investigations in the subject had practically ceased, pending the development by the Marconi Company of a dependable and useful system for lightship and lighthouse communication, a certain amount of real progress was undoubtedly made, chiefly in the way of enhancing the range of communication by steps in the direction of a syntonised or tuned system. The nine miles bridged in the Bristol Channel experiments by imperfect apparatus connected on an erroneous principle became sixteen miles at Bournemouth, sixty miles during naval manœuvres between battleships, and thirty-two miles of fairly reliable communication across the Straits of Dover. There is no doubt that the principal improvement introduced to give these results consisted of the oscillation transformer for receiving. Though still a very imperfectly constructed appliance the use of this instrument corrected the serious error introduced by the placing of the coherer directly in the aërial lead, and thereby enabled the tuning of the aërial receiving system to be made use of. It is very doubtful, however, whether any really effective tuning of the secondary or coherer circuit could have been attained by the type of oscillation transformer in use at this stage, with its many-layered windings. Without a doubt the main object it was intended to fulfil was to step up the E.M.F. of the received impulses and so augment their effect on the coherer. The proposal to utilise a small air-core transformer for this purpose had originally been made by the writer quite early in the year 1897. There is, however, a wide difference between the use of such an appliance as a step-up transformer simply, and its use as a means of securing a separate closed oscillating circuit, which is its proper function. In the one case the ratio of the primary and secondary windings determines the E.M.F. developed at the detector terminals, in the other it is purely a question of the proportions of inductance and capacity used which determine the resultant E.M.F., and it is quite common for a "step-down" ratio of the windings to produce a secondary E.M.F. many times greater than the primary. In other words, tuning to resonance by means of large inductance and small capacity always determines a large resonance E.M.F., even though the main inductance be

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entirely dissociated from the oscillation transformer and is not under the inductive influence of the primary circuit in any way. Conversely, the association of a large capacity and small inductance to give resonance determines a small resonance E.M.F. but a large current. Therefore, though the introduction of the receiving transformer was a step towards making fuller use of the principles of resonance, it follows that it was not the essential improvement which distinguishes modern syntonised wireless methods from the earlier tuned arrangements. Even with the transformer the only tuning really made use of was that due to the aërial and primary circuit, and as the damping is there so considerable, both by reason of inherent dissipation losses in the system, and in virtue of its radiating properties, it is not surprising that tuning was but partly realised at this stage.

SCOPE OF TUNING IN WIRELESS TELEGRAPHY.—It will be convenient at this point to consider the various principles embodied in the somewhat generic title of "tuning." Improved efficiency in communication, by utilising to the fullest possible advantage the properties of persistently vibrating circuits, is the object aimed at. In the transmitter, as originally arranged, fairly persistent vibration is attainable with due care in insulation of the aërial conductor so as to minimise as far as possible all leakages, undue dissipation at point of connection to earth, with suitable spark-gap adjustment, and with a spark-coil which is suitably proportioned to the capacity of the aërial conductor. A clear, almost straight, white cracking spark without flaming or arcing tendency is an indication of healthy oscillations. This condition is best attained by the use of as small a coil and as small a power as is just necessary to ensure its steady maintenance. Superfluous power tends to destroy the correct sparking conditions at the discharge gap, and poor insulation is at once fatal even though a discharge is obtained for every primary interruption. The conditions are not always easy to obtain, but when once found the signals are so definite and amenable to the tuning adjustments of a modern receiver that the fallacy of dead-beat or whip-crack oscillations only being given out by this transmitter is at once acclaimed. It is, however, only possible to adjust the frequency of oscillation over a relatively small range in this type of transmitter, except by adjustment of the external aërial, as the inclusion of even a small amount of inductance so reacts on the character of the spark as to quickly destroy its oscillating qualities. This effect has to do with the small capacity discharging, combined with the lengthened time per oscillation, the necessity for increased duration of spark maintenance per discharge, in order to get a sufficient number of effective alternations of current, and the rate of re-combination of ions in the discharge path. These factors all tend towards increas-

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ing the spark resistance beyond that permissible by considerations of damping. In those cases where direct earth connection is not used, the same conditions also apply, but no doubt to a modified degree. This question is one which does not appear to have been fully investigated, however, and it is possible that the spark-gap and circuit conditions may be so arranged that the necessary ionisation of the spark-gap is maintained by current from the transformer or spark-coil instead of by the capacity discharge simply. The conditions are then rather those of the high-frequency singing arc than those of the spark type, and the purity of the wave-trains emitted becomes a doubtful quantity.

Mainly in view of the above limitations, and on account of insulation troubles, the closed circuit method of transmission has great advantages, quite apart from considerations of "coupling" effects. It has, however, come to be regarded as a necessary means of obtaining persistency of vibration in the transmitter, and to this view the writer's experience is distinctly opposed. Given proper circuit conditions, proper spark-gap adjustment and spark coil properly proportioned to the capacity of the aërial system with an efficient interrupter, sufficient persistency for all ordinary tuning purposes and to secure maximum range of communication can be obtained from the open circuit transmitter. The drawbacks lie in the practical maintenance of the necessary conditions of adjustment, insulation difficulties, live aërial and large electrostatic induction from aërial to neighbouring telegraph and telephone wires, etc. So long as the maximum range of communication or anything approaching the maximum range of communication is obtainable from a transmitter, there can be no such effect as dead-beat or "whip-crack" emission of waves concerned, for it is by resonating in the receiver to the successive vibrations of the transmitter and by that alone that long distance communication is possible. Any doubt on this point should be removed by the consideration of two independent pairs of communicating stations, all of which are operated as open circuit transmitters and simple receivers (say with low-resistance thermal detectors or thermo-galvanometers connected directly in the aërial and no tuning appliances). If each pair have aërials of entirely different capacity, say one pair furnished with large capacity "carpet aërials" and the other pair with simple aërials, thus having widely different "tunes," there will be an almost total absence of interference. That is, if a and b are one pair and x and y the other, then it will be found that in order to make a communicate with x or y it will be necessary to bring the two stations into very close proximity indeed as compared with the signalling range either of a to b or x to y. If this proves anything at all it is that quite a considerable

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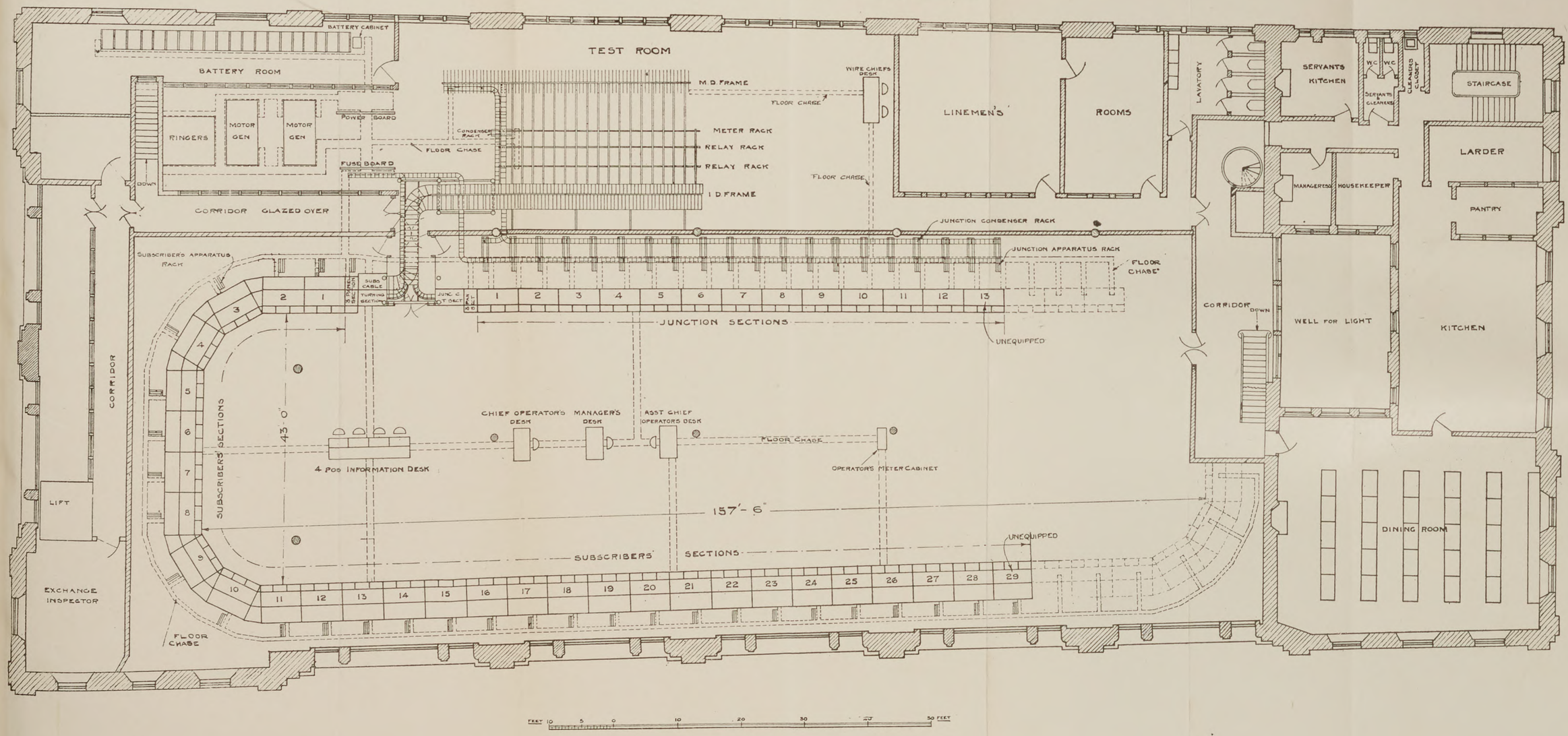
FLOOR PLAN-G.P.O. CENTRAL EXCHANGE-GLASGOW.



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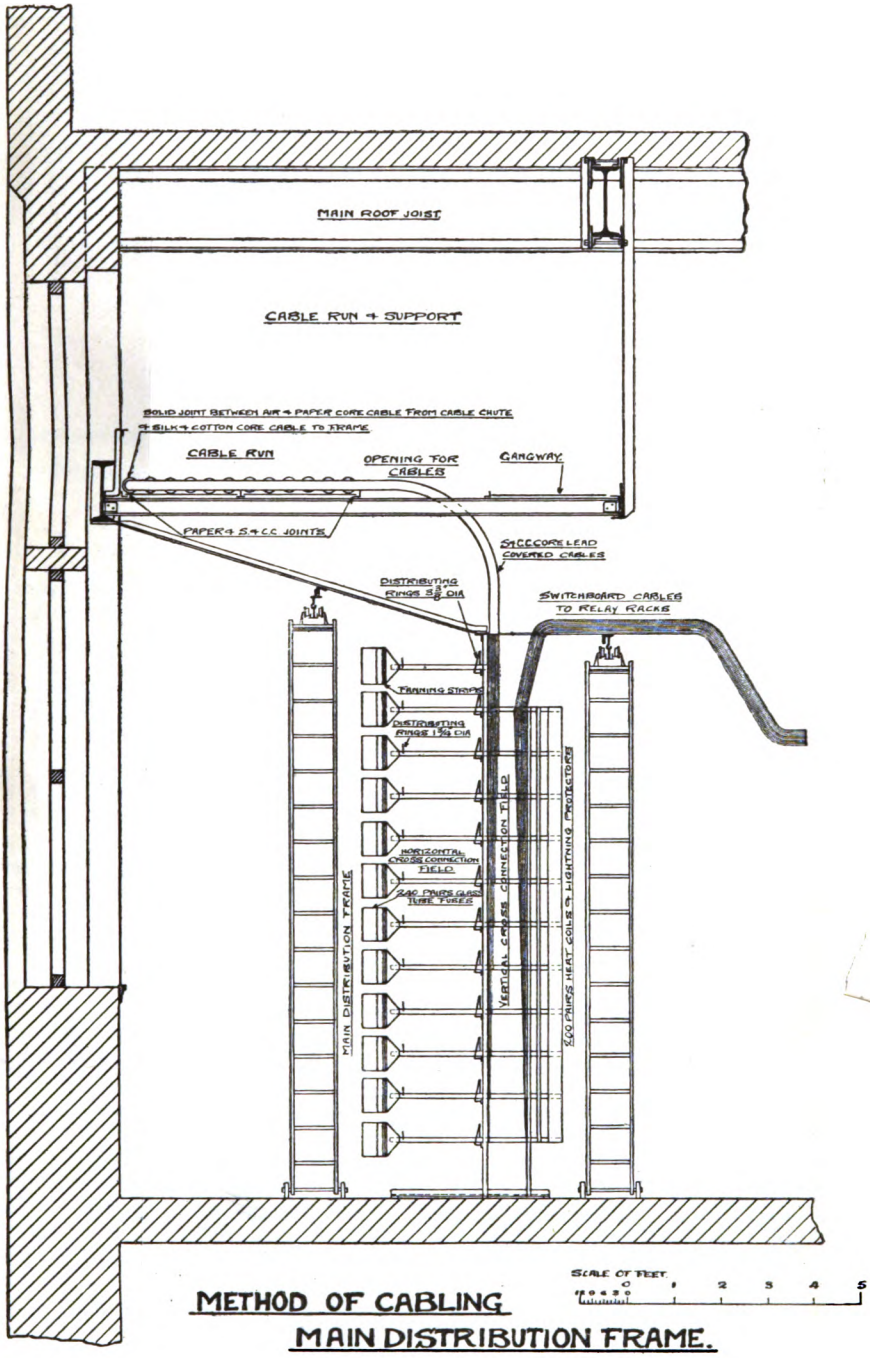
MAIN ROOF JOIST
CABLE RUN & SUPPORT
SOLID JOINT BETWEEN AIR & PAPER CORE CABLE FROM CABLE CHUTE & SILK & COTTON CORE CABLE TO FRAME
CABLE RUN
OPENING FOR CABLES
GANGWAY
PAPER & S & C.C. JOINTS
SAC CORE LEAD COVERED CABLES
DISTRIBUTING RINGS 3/8" DIA
SWITCHBOARD CABLES TO RELAY RACKS
TRAINING STRIPS
DISTRIBUTING RINGS 1 3/8 DIA
HORIZONTAL CROSS CONNECTION FIELD
240 PAIRS GAS TUBE TYPE
MAIN DISTRIBUTION FRAME
VERTICAL CROSS CONNECTION FIELD
600 PAIRS HEAT COILS & LIGHTNING PROTECTORS
SCALE OF FEET
0 1 2 3 4 5

METHOD OF CABLING MAIN DISTRIBUTION FRAME.

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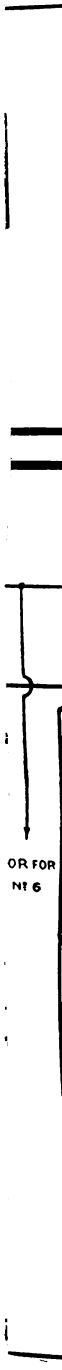

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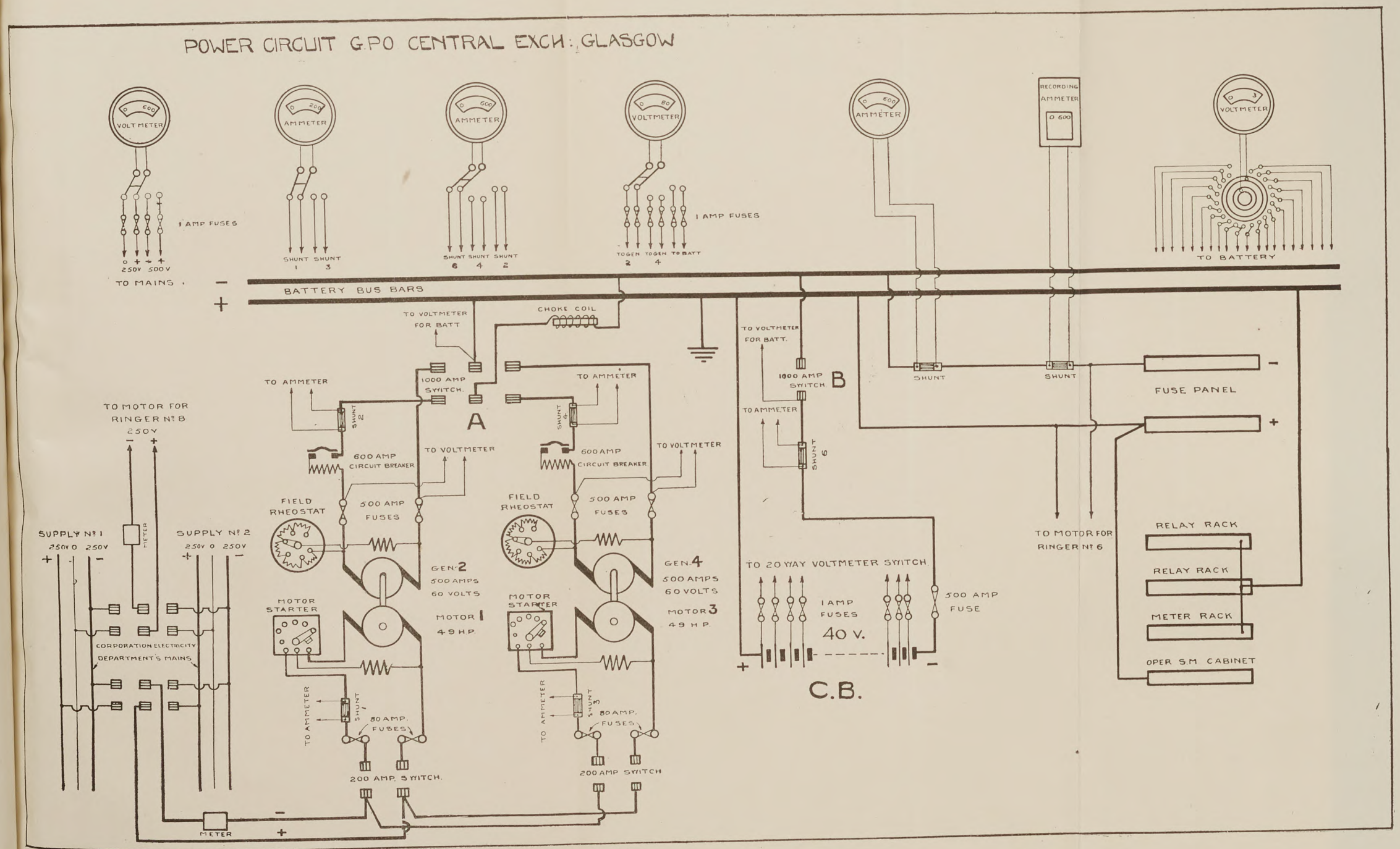
POWER CIRCUIT G.P.O CENTRAL EXCH: GLASGOW



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RINGING MACHINE CIRCUIT - CENTRAL EXCHANGE - GLASGOW

SPEED-10 R.P.M

·75 SEC MAKE
75 SEC BREAK

·75 SEC. MAKE
·75 SEC. BREAK

1 SEC. RING 2 SEC INTERVAL

WIRING OF RINGER 6 TO BE SIMILAR TO THAT OF RINGER 8 EXCEPT THAT IT IS WIRED TO OPPOSITE SIDE OF SWITCHES

#14 S.W.G

SPEED-1000 R.P.M. RINGER 6

8 INTERRUPTIONS PER REV

6.

24 INTERRUPTIONS PER REV

SPEED-1000 R.P.M. RINGER 8

8 INTERRUPTIONS PER REV.

8.

24 INTERRUPTIONS PER REV

7/15 S.W.G

GEN.R WINDING

GEN.R WINDING

BELT DRIVE

BELT DRIVE

MOTOR STARTER

MOTOR ·4 HP

MOTOR STARTER

MOTOR ·4 H.P.

7/15 S.W.G

3/18 S.W.G

5 AMP FUSES

5 AMP FUSES

20. AMP CHOKE COIL

40 VOLTS

TO MAINS SWITCH 250V

#14 S.W.G

#14 S.W.G

7/15 S.W.G

TO FLASHING CIRCUIT INFORMATION DESK

#14 S.W.G CLEAR FOR TRUNK

7/18 S.W.G TO 400Ω RELAYS INCOMING JUNCTIONS FROM TRUNK EXCHANGE

·03Ω

385Ω

·03Ω

#14 S.W.G

385Ω

TO SW BDS BUSY BACK CIRCUIT

·16Ω

800Ω RETURN

·08Ω

TO TEST & PLUGGING UP LINES

40V

5 AMP FUSE

JUNCTION OPER'S RINGING

SUBS. OPER'S RINGING

#14 S.W.G

E

TO + BUS BAR ON FUSE PANEL

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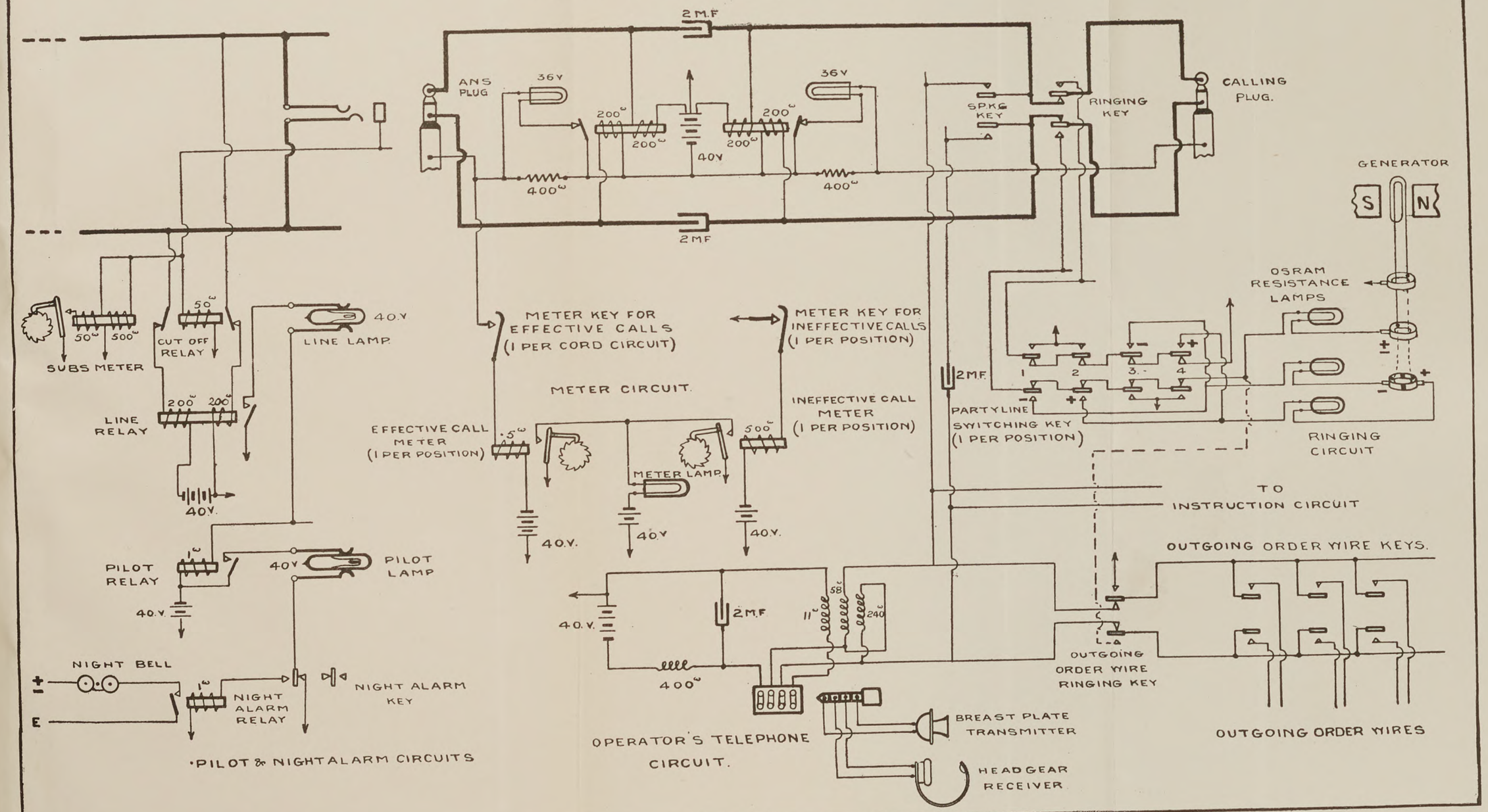
SUBSCRIBERS LINE & CORD CIRCUITS



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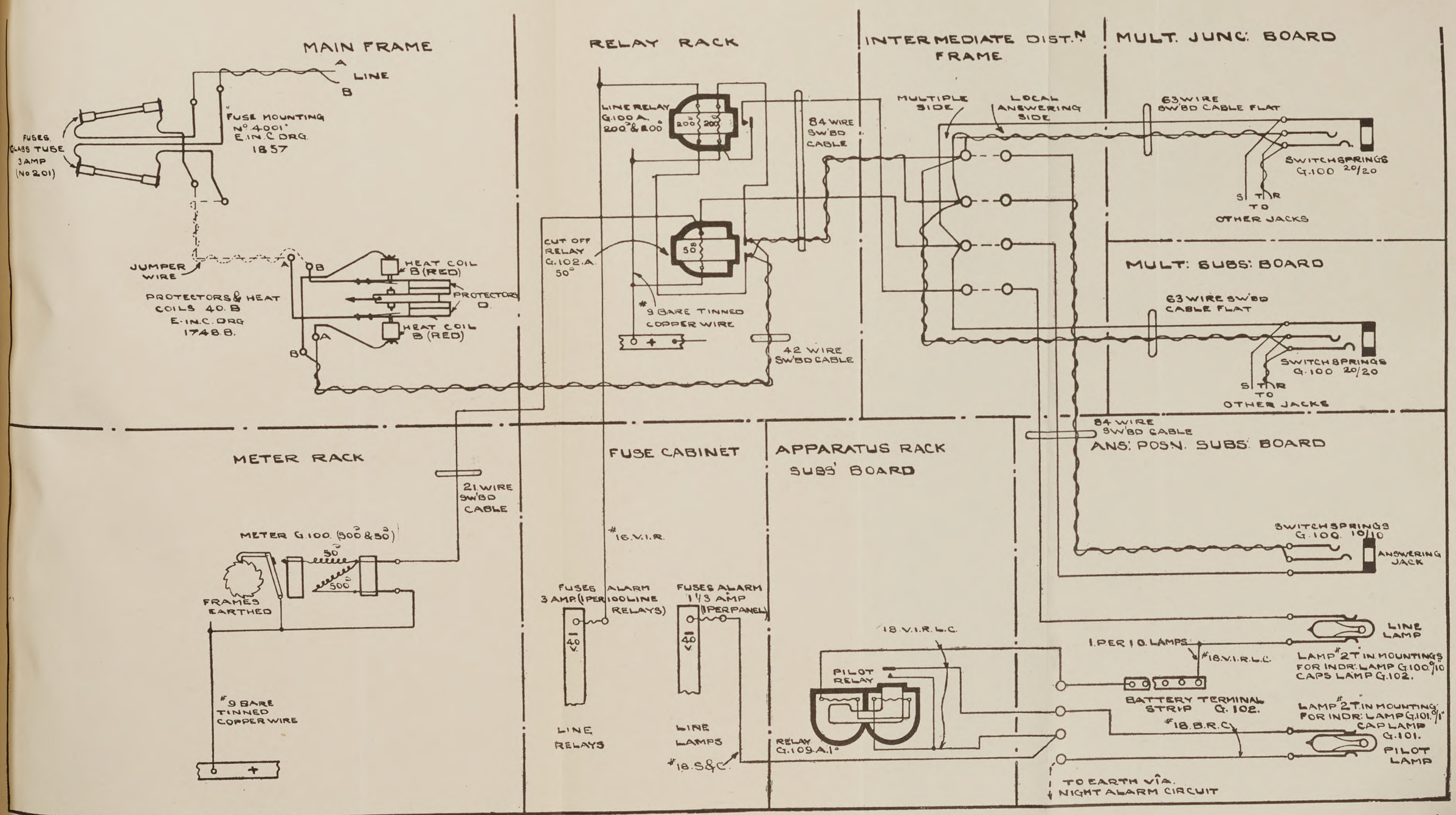

Wiring Subscribers' Line Circuit.

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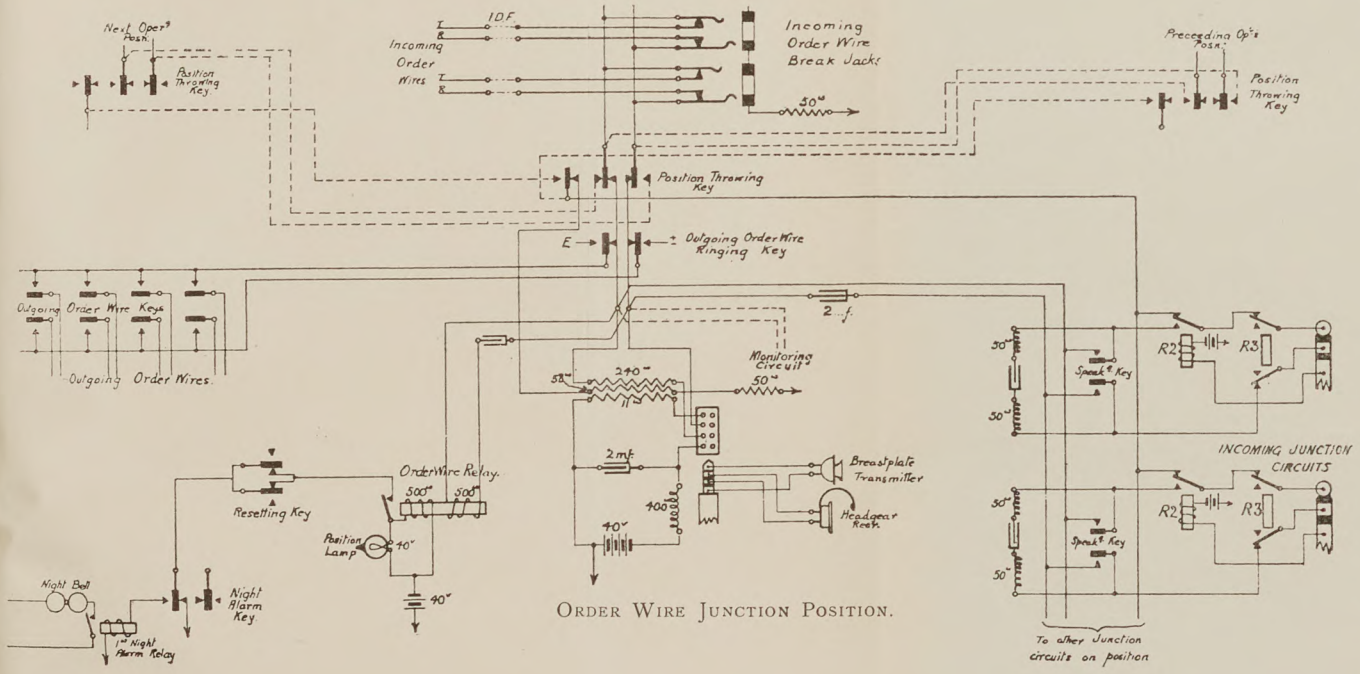
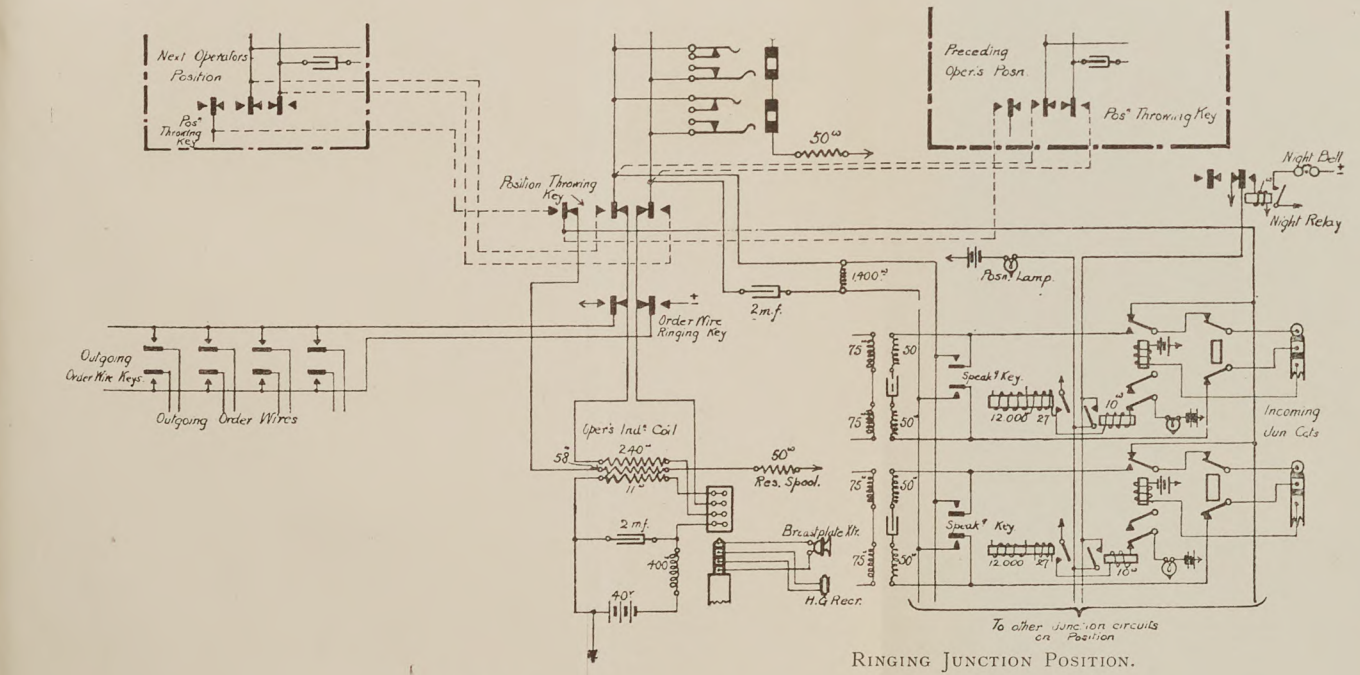


ORDER WIRE JUNCTION POSITION.



RINGING JUNCTION POSITION.

"B" OPERATOR'S TELEPHONE CIRCUITS.

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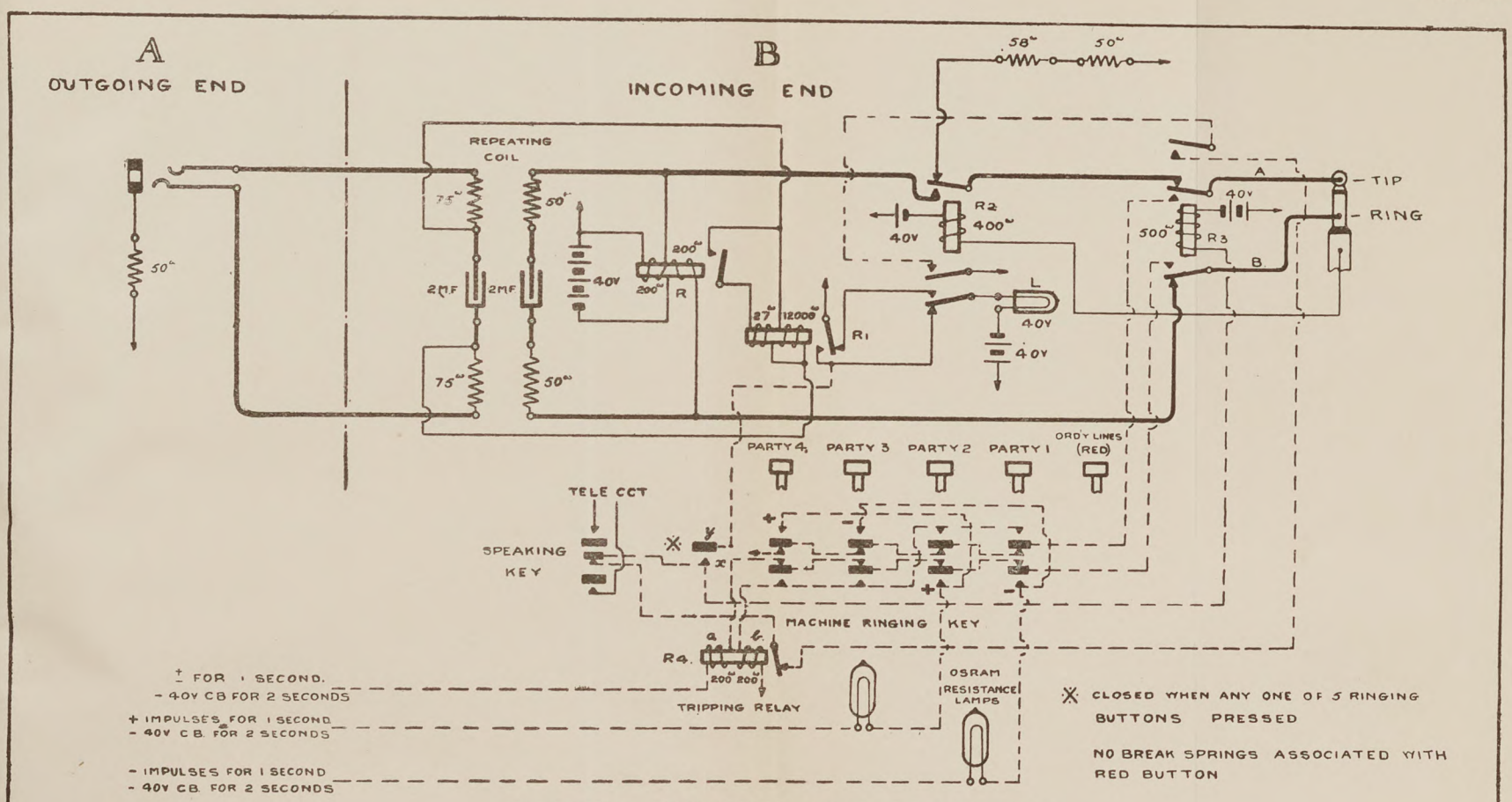
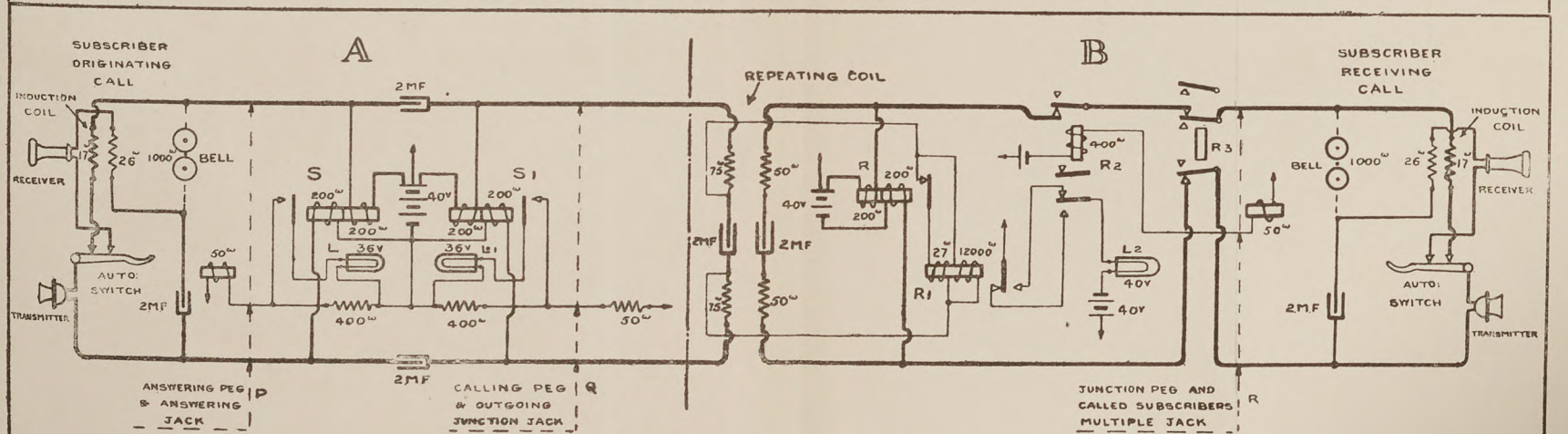


INCOMING JUNCTION FROM C B EXCHANGE
ORDER WIRE WORKING.



SPEAKING & SIGNALLING CIRCUIT
SUBSCRIBER TO SUBSCRIBER VIA JUNCTION

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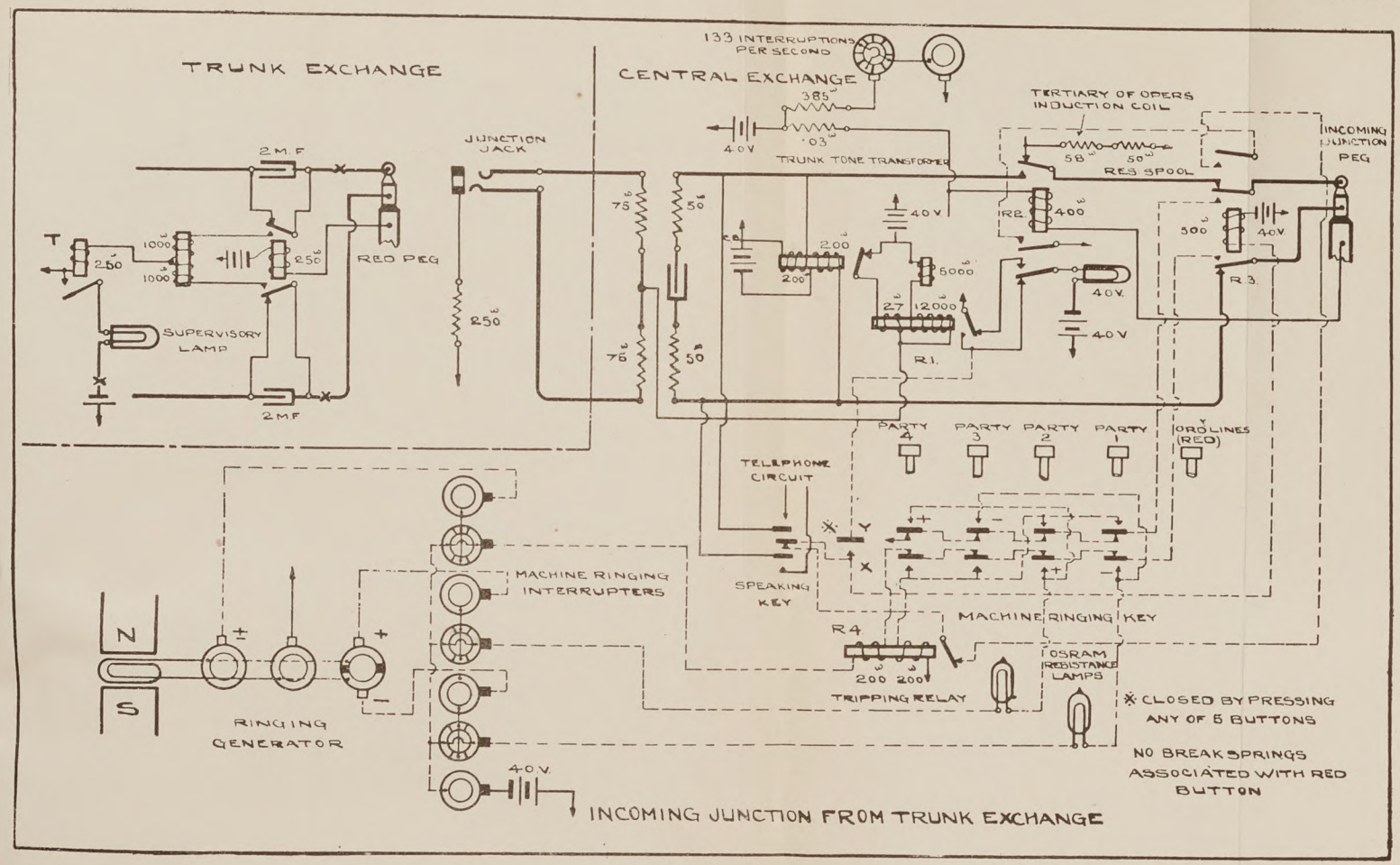

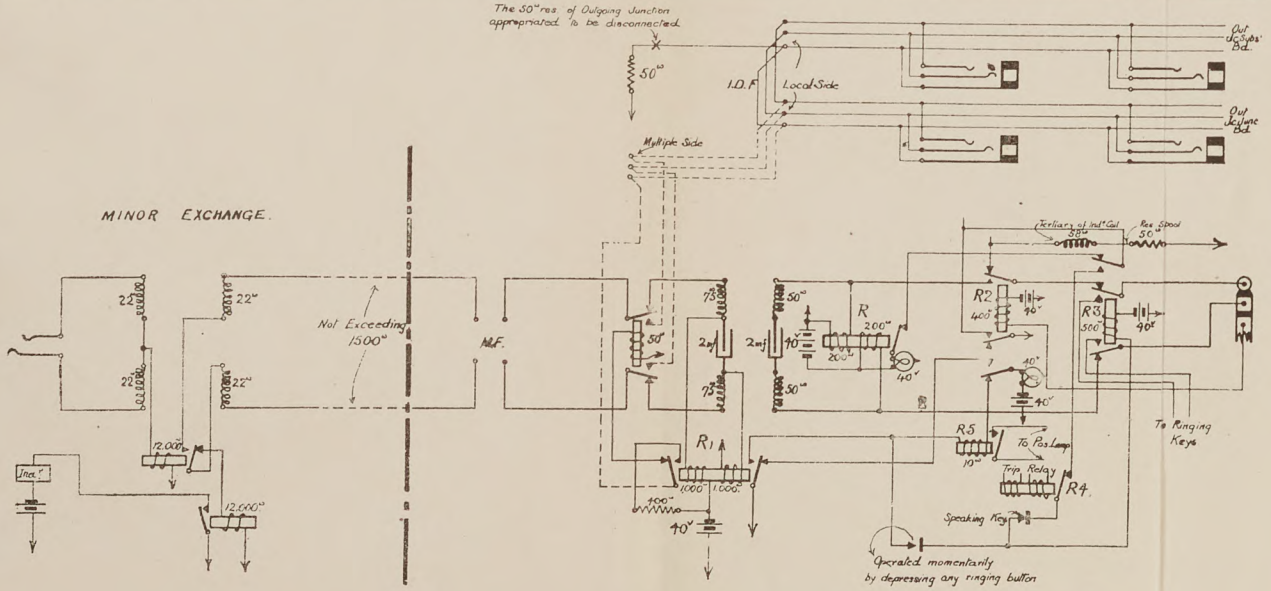

Two-way Junction.

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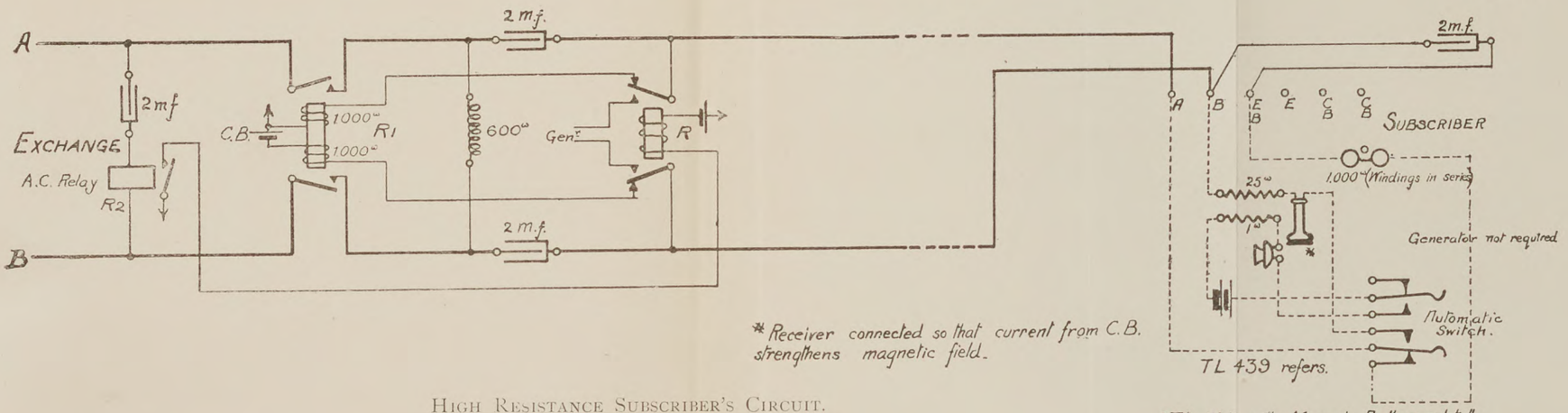
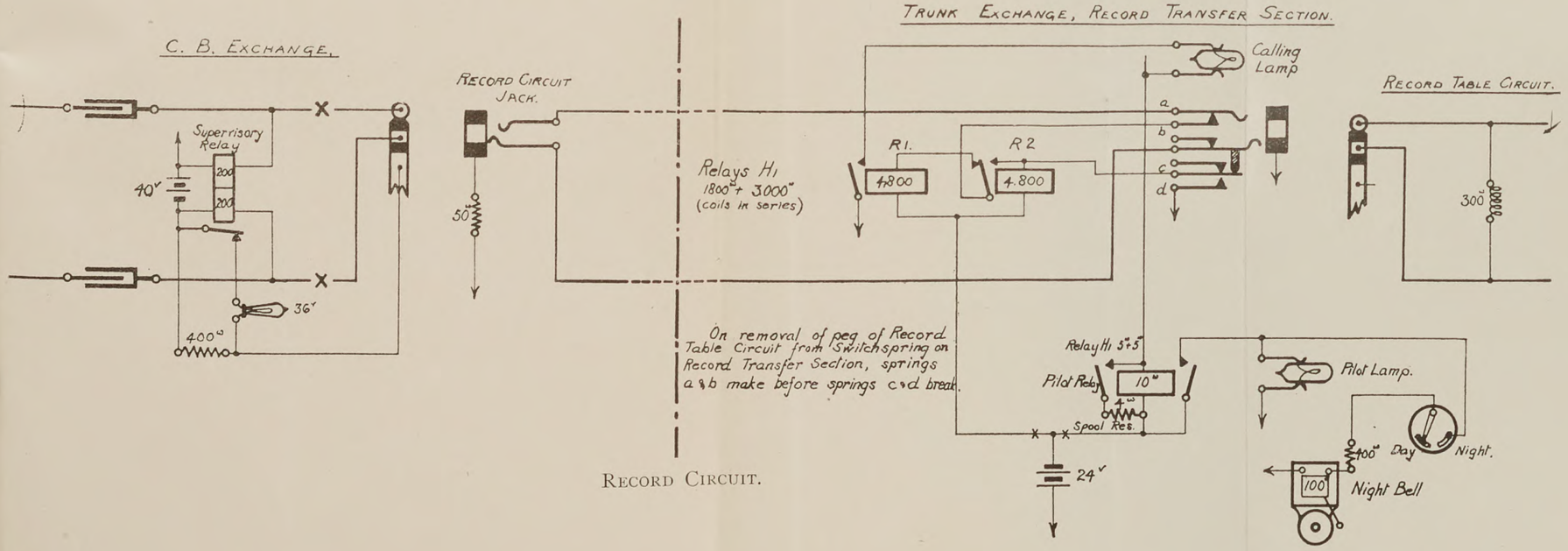


HIGH RESISTANCE SUBSCRIBER'S CIRCUIT.



RECORD CIRCUIT.

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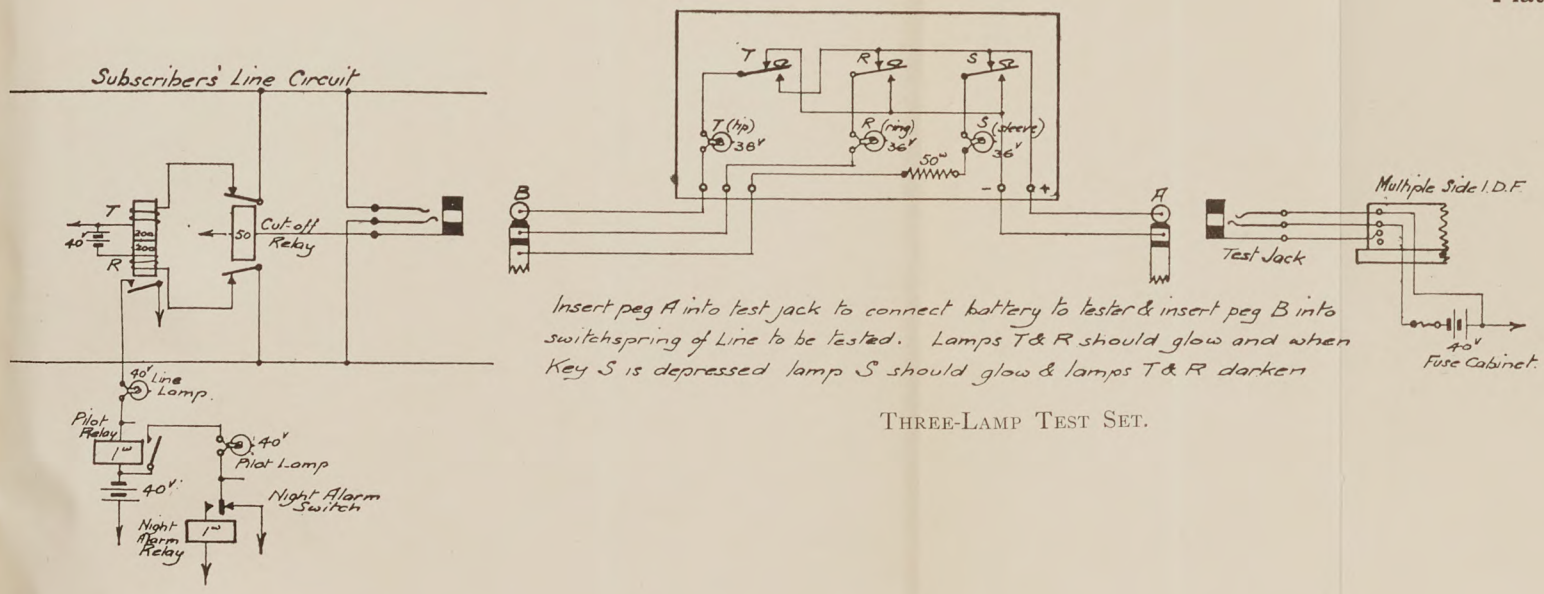
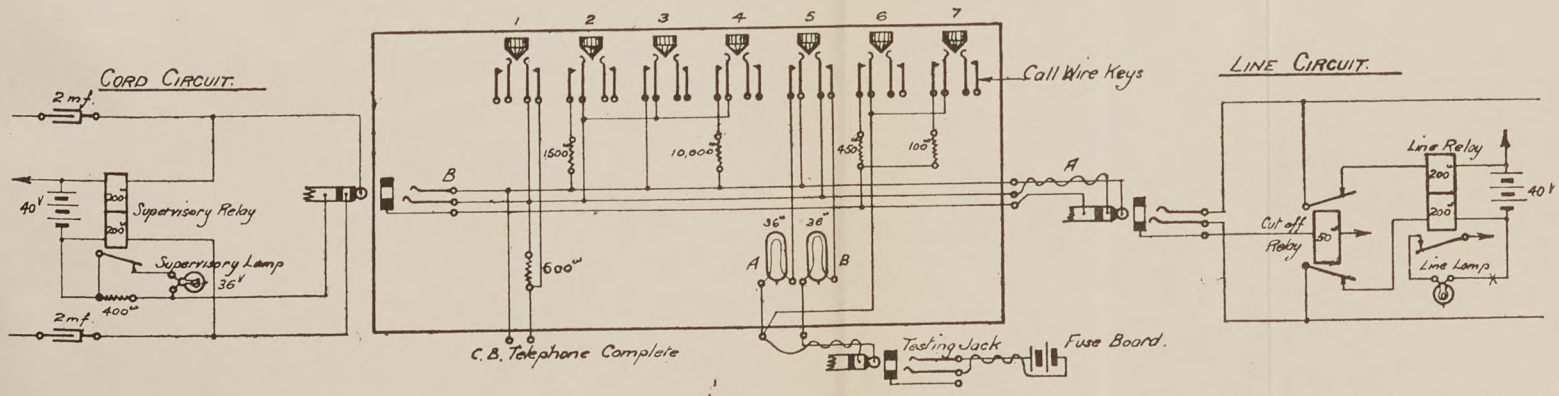


THREE-LAMP TEST SET.



APPARATUS or CIRCUIT UNDER TEST	1ST. OPERATION.	2ND OPERATION.	3RD OPERATION.
Line Relay	Join Battery to Test Set and insert Peg A into Answering Jack of Line under test.	Depress Keys 2 & 3 alternately, Line lamp should glow in both cases.	
Cut-off Relay	ditto	Keeping Keys 2 & 3 depressed Keys 6 & 7 should be operated singly and together, the Line lamp should be extinguished with each condition, A badly regulated relay is shown up by varying the resistance by means of Keys 6 & 7.	
Cord Circuit Subscribers & Junction.	Join Battery to Test Set and insert Peg A into spare line to pick up 50ω to E. on sleeve Connect peg of Circuit under test with Switchspring B.	Keeping Key 4 depressed and operating Key 2 approximately 3 times a second the supervisory lamp should alternately glow & darken. The supervisory relay should be adjusted so that similar results will be obtained when Key 3 is operated. The action should be definite in both cases.	By operating Key 5. the glowing of lamps A & B will prove the continuity of the cord circuit.
Mem :- The telephone connected to Key 1 is used in connection with the test on Incoming Junction circuits. The Key is thrown when testing the Junction ringing keys through 600ω & S.C. alternately.			

LINE AND CORD CIRCUIT TEST SET.

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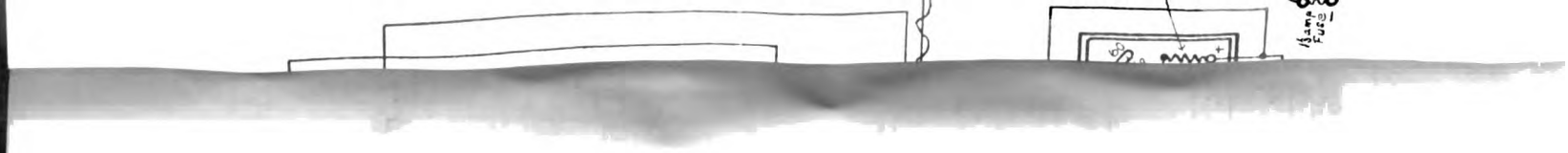

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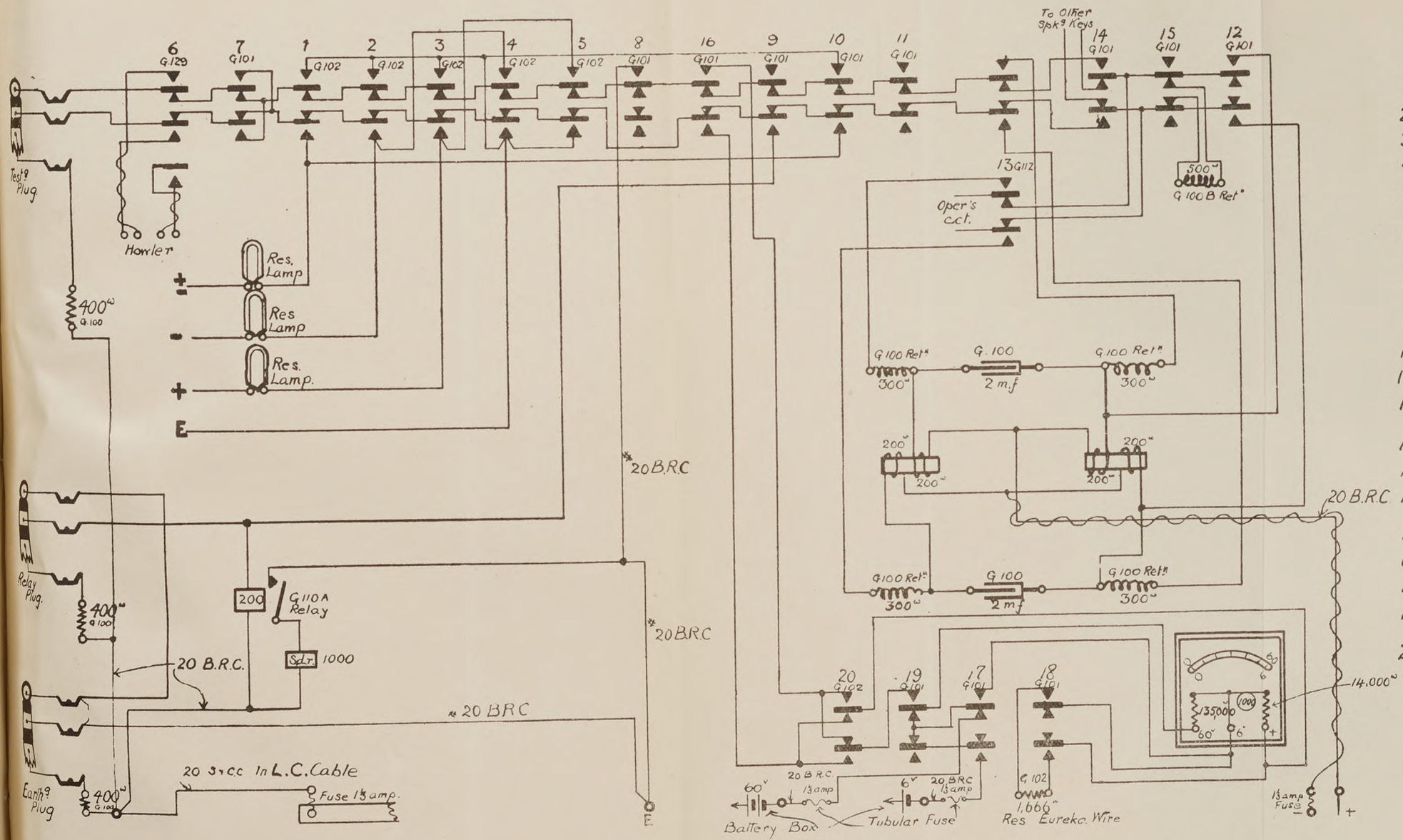

Order of Keys & Labelling

1 Ringing
2 Ring Party 1
3 " " 2
4 " " 3
5 " " 4
✱
6 Howler
✱
7 Line Reversing.
8 Earth
9 Relay
10 Continuous Ringing.
11 Spare
12 Battery
✱
13 Speaking Test
14 Speaking
15 Ret Coil
✱
16 Voltmeter.
17 Battery Switching.
18 Voltmeter Shunt
19 Battery Cut-off
✱
20 Voltmeter Reversing
✱ Key Spaces

TESTING CIRCUIT, WIRE CHIEF'S DESK.

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number of effective oscillations per train are involved in the case of each open circuit transmitter.

Tuning or syntony is not, therefore, a characteristic of any one system of wireless telegraphy. It is only the sharpness or degree of tuning attained that differentiates methods, and so far as transmitters are concerned the differences manifested are not of a striking order.

With receivers of various types the case is somewhat different. Most types of detector available demand the use of a separate closed oscillation circuit, hence it is essential for good results that the fullest use be made of syntony or tuning. Especially is it the case with the filings coherer, which until A.D. 1899 was practically the only detector available. To interpose a detector like the filings coherer, the Lodge mercury-wheel, the electrolytic or many forms of thermal and crystal detectors having high resistance in the direct path of the "aërial to earth" oscillation system would be all but fatal because of the excessively large damping produced in the system. Such a receiving arrangement might very well be termed "untuned." It would also be practically unworkable. The first important step towards making full use of the properties of persistent vibration in a receiving station then is to set the "aërial to earth" system free to vibrate, to avoid hampering its vibrations by the method of joining up the detecting device. The plan of joining the coherer across the secondary terminals of a small transformer, as adopted by Marconi in A.D. 1899, effects this first step fairly completely, but it still leaves much to be done to gain the full benefits of tuning. In the first place, there still remains inherent to the "aërial to earth" oscillation system a large damping factor, generally of the order of 30 to 50 dissipative ohms, mainly arising, no doubt, from the ground being but an indifferent conductor. Seeing that a circuit is non-vibrating unless $R < \sqrt{\frac{4L}{K}}$, it follows that damping of the foregoing magnitude in a circuit of relatively large capacity and small inductance cannot but have a very appreciable effect on the persistency of vibration and on the efficiency of the receiver. Nevertheless well-developed resonance effects are exhibited, and this system is capable of tuning adjustment by added inductance or series capacity to adapt it to vibrate over a very large range of frequencies. With just such a receiving system, or one only slightly better tuned, Marconi succeeded in demonstrating (in A.D. 1900, between the Needles and Poole) the possibility of diplex wireless signalling.

The second important step in syntonising the receiving system is to make the secondary circuit of the transformer, including the detector, a persistently vibrating circuit. If the detector be a filings coherer or mercury wheel coherer it will act as a condenser of very

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small capacity up to the time coherence is effected. It will therefore only be necessary to wind the secondary of the oscillation transformer, as it may now be termed, with a sufficient number of turns of wire to provide inductance such that capacity × inductance is equal to the product of the same two quantities in the aërial and primary system, both being, of course, adjusted to suit the wave length of the communicating station and to give maximum resonance on that wave. The winding of the secondary must not, however, be layer upon layer but must preferably consist of a single closely wound layer only, otherwise there will be heavy losses due to large compensatory condenser-currents circulating in the windings, *viâ* the capacity formed between contiguous layers. Further, the winding must possess low resistance, otherwise damping will ensue. If, however, too low a resistance be aimed at, the object will again be defeated by reason of the large surface of conducting-wire presenting electric capacity relatively large compared with that of the coherer. Hence the size of the transformer and the gauge of wire to be used to obtain the desired inductance has to be a compromise, determinable by experiment only. Nor is this the end of the tale, for the capacity of the coherer is not precisely constant nor is the capacity of the windings negligible. For these reasons it is found that a tiny adjustable condenser (usually made of a small glass tube with a fixed internal metal cylinder and an external sliding metal sleeve) shunted across the coherer so as to increase the total capacity, will decidedly enhance the sensibility whilst at the same time affording a convenient means of accurately tuning the system and conferring stability on the coherer responses. Attention to detail in this part of the receiver is all-important, and there is yet another point concerned. Apart from the direct resistance losses there are dissipative resistance losses which become more and more pronounced as the gauge of wire used in winding the transformer is increased. These are mainly due to magnetic leakage through the windings, which, in the high rate of alternation of the magnetic field, determine eddy-currents in the solid copper wire. To reduce these losses the wire should be stranded, each strand being separately insulated with a single covering of fine silk. But here again a compromise is necessary. If divided into too many strands there is, besides an undue increase of capacity, a liability for the oscillating currents to traverse the different strands unequally and with small phase differences. As all the strands are necessarily bunched at their terminations the phase differences will determine compensatory or controlling currents in complete circuits along one strand and returning by another or others. In practice the most judicious compromise is found to be obtained by using a conductor of only three or four strands for winding the oscillation transformer.

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The details of construction of oscillation transformers and inductances for use with other types of detector possessing different electrical constants are necessarily different to those giving the best results with coherers, but the character of the losses and means of ensuring minimum damping are similar in principle.

The explanations in connection with the tuning of transmitters and receivers so far given have purposely left out of consideration a further principle of prime importance in order that it may be given special attention in view of its far-reaching consequences in all systems involving coupled transmitters or receivers. Over and above the simpler problems of damping and resonance the coupling together of any vibratory systems, electrical or mechanical, open circuit to closed circuit, or closed circuit to closed circuit, involves a principle which is embraced by the theory of couplings. Whenever two or more vibrating systems of the same vibration period are connected together in order that one may excite the other, each mutually hampers the other and interferes with the proper periodicity as determined by the individual constants of each system. The theory covers also the further case of a vibrating system excited by a non-vibrating source of energy applied externally to the system, *e. g.* the escapement mechanism of a clock or watch where the mechanically vibrating system is supplied with energy from train work, or a Poulsen arc where the electrically vibrating system is supplied with energy from a direct current source. In brief it tells us that to preserve the maximum freedom of vibration and isochronism, the vibrating system must be left alone and uncoupled to anything. The question thus becomes, how to get what is required from the vibrating system while interfering as little as possible with it.

In the particular problem in reference to coupling, presented in wireless telegraphy, a compromise is of course necessary, and the point to determine is the degree or strength of coupling which, while affording sufficiently sharp resonance, will ensure sufficient range or sufficient immunity from interference with the power at disposal. The theory tells us that by indefinitely loosening or weakening the couplings at the transmitter and receiver respectively, assuming negligible damping in the closed circuits of each, it is possible to determine a sharpness of tuning, and an immunity from interference, as great as we please, that is, to determine as much wave selectiveness as we please; but that beyond a certain stage of reduction the primary applied power will have to be increased *pro rata*, or, conversely, the range of communication will be diminished.

There are two ways at least in which degrees of coupling, or coupling co-efficients, as between resonant circuits in wireless telegraphy,

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may be defined. Mathematically it is usual to define the coupling co-efficient in terms of the ratio of mutual induction to the geometric mean of the self-induction co-efficients of the two circuits. To measure it practically in this way, however, would be both difficult and tedious, for it is much easier to talk of the inductance and capacity of a wireless aërial than to determine the real effective inductance or capacity with anything like accuracy. Moreover, both quantities are different for different wave adjustments, apart from the addition or subtraction of inductance coils of known value used in tuning, because the current distribution along the aërial changes with change of wave adjustment. For some years a much more convenient, even if less accurate, plan has been used by the Admiralty. This depends on the effect which the coupling has on the character of the wave emission at the transmitter, and it will first be desirable to explain this effect. By reason of the mutual reaction between them, strongly coupled resonant circuits always possess two distinct rates of vibration and emit waves corresponding to both. The two circuits never vibrate in phase; one is always driving the other and is retarded in vibration-rate, whilst the other is quickened. First one acts as the driving circuit until its energy is passed over to the second, then the latter in its turn becomes the driving circuit, and so on. The stronger the coupling the more pronounced are the two waves emitted and the greater the difference in the vibration-rates. By measuring with a wave-meter each of the waves, their wave-length difference can be ascertained, and this can be expressed as a percentage difference from the mean of the two wave-lengths. Thus, a coupling determining two waves each differing by 20 per cent. from the mean wave-length may be called a 20 per cent. coupling, and as the coupling is weakened the percentage is reduced. In practice a 5 per cent. coupling may generally be taken as a fairly weak coupling. Accuracy of measurement by this method depends on obtaining well-defined wave-meter readings and cannot at present be said to be more than approximate, but with improved wave-meters better results will doubtless be forthcoming.

In the earlier stages of closed circuit wireless applications the couplings used were of the "tight" or strong order, 20 and 30 per cent. being quite common. The effect of a progressive reduction, both at the transmitter and receiver, is to first increase the range of communication quite considerably, followed by a gradual diminution. The stage at which maximum range is obtained, depends on the efficiency of the vibrating circuits concerned, both in the transmitting and receiving stations. With circuits carefully designed to give very small damping the maximum range of communication will be obtained with weaker coupling than otherwise; hence the great importance of attention to all details tending towards a reduction of damping.

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The full advantages of reduced coupling are only realised when similar degrees of coupling are used at both communicating stations in the sending as well as the receiving circuits. A weakly coupled transmitter will not communicate with a strongly coupled receiver over as great a range as with a receiver having a suitably weak coupling. The form of detector used is also a controlling factor in determining the full benefits of reduced coupling, inasmuch as many forms introduce dissipative resistance into the receiving circuits. The filings coherer and mercury-wheel coherer are examples of detectors to which a high degree of resonance is applicable, as is also the Peddersen "tikker"; the latter, however, is only properly adaptable for use with continuous wave systems. The magnetic detector also is capable of being suitably wound to develop highly syntonic properties, its dissipative properties being controllable. The electrolytic receiver, on the other hand, is not so susceptible, but in view of its extreme sensibility it is possible to develop quite as high a degree of syntony with it by the use of special tuning circuits, though at some loss of sensibility.

With regard to the immunity from interference obtainable by reduction of coupling at the receiver, it should be explained that this refers mainly to interference by waves from other sources. A considerable degree of immunity from atmospheric disturbances and from disturbance due to electrostatic induction is also conferred, but these are not "wave interference" and cannot be completely eliminated by any reduction of coupling. Atmospheric disturbances are of the nature of abrupt local changes in the potential of the atmosphere, and as such must determine sudden changes in the inductive charges on wireless aërials. Hence high and extensive aërials are more prone to their baneful influence than low aërials. Abrupt changes in the electrostatic induction on an aërial, excites electrical oscillations thereon, the period of which is determined by the "tune" of the aërial. Therefore these atmospheric disturbances acquire the fundamental period of vibration of the aërial circuit itself, that is, the period to which the receiver is tuned, and are not capable of being wholly "tuned out." That they are partially tuned out is attributable to the fact that they do not consist of highly persistent vibrations, because of the damping inherent to an earthed aërial.

It is also to be noted that reduction of coupling at the transmitter so modifies the character of the trains of waves emitted that it robs them of much of their power of interfering with other receivers not adjusted to respond to those waves.

This digression (on the tuning problem) into the realm of modern practice has been made in order to conduce to a better understanding of the relative stages of development of early systems, and to assist in an appreciation of the relative importance of the various steps made.

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THE FORTH BRIDGE CABLE.

By A. J. STUBBS, M.Inst.C.E., M.I.E.E.

WHEN dealing with main route cables the telegraph engineer is more or less used to facing maintenance difficulties due to the operations of roadmen, who think it sufficient to plug with clay a pick-hole in a lead-covered cable, to damage by "burn-outs," or electrolytic corrosion by leakage from electric light and power mains; to breaks caused by settlement following sewer operations, or, more occasionally, in mining districts, by caving in of abandoned workings. Even the vibration of railway traffic has been credited with the destruction of lead coverings of cables through tunnels; but fortunately it is not often that day-by-day contraction and expansion of the roadway has to be taken into account when settling a cable route. Yet this has had to be the main consideration recently in dealing with the renewal of the cable over the Forth Bridge.

The Bridge which crosses the Forth between Dalmeny and North Queensferry, about nine miles above Leith, is the property of the Forth Bridge Railway Company, and is used by the North British and other companies. There are two main spans, each of about 1918 feet, and two smaller spans of about 758 feet (centre to centre of piers), formed by three huge double cantilevers, the central one being 1620 feet long and the other two each about 1515 feet. These are connected by two girders 350 feet long. Shorter spans of ordinary viaduct construction extend from the shoreward ends of the outer cantilevers, making up a total length of almost exactly a mile, and a further half mile of viaduct form the approaches. An inner viaduct supported on trestles and cross girders is carried through the cantilevers and forms the road upon which the track is laid.

In 1903 it was decided to replace the existing G.P. cable by a 42/70 air-space paper-core cable two inches in diameter and weighing about nine tons per mile. It was recognised that special provision was needed for the expansion joints at the ends of the cantilevers, where a variation in length of nearly five inches is frequently registered during twelve hours. Accordingly, double solid plugs were introduced at those points. Single solid plugs terminated the cable at each end, from which G.P. quads were taken down the great piers to the huts on the north and south banks. Trouble was experienced from the first, and before the cable was actually brought into use (January, 1905) special reconstruction had been needed, including the renewal of all the original plugs and the insertion of others at the small expansion joints at the Dalmeny (south) end of the bridge.

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This cable was placed in wooden troughing laid in the centre track (6-foot way) of the bridge. No doubt the main cause of the maintenance troubles that were experienced throughout its life was the rapidly alternating contraction and expansion to which its exposed position subjected the whole cable, while the corresponding movements of the bridge contributed not a little to the result. Also the position selected proved to be an unfortunate one, as the operations of the bridge engineer in making repairs to the decking of the bridge involved shifting the troughing bodily from one side to the other of the 6-foot way, in sections as required—a movement so vigorously

1.—Overturned Troughing containing previous Cable.

effected that the casing more than once was lying on its side for a considerable length! All these conditions combined to so tear the main sheath and to give such abnormal difficulty in maintaining the joints that it was decided last year to entirely replace the cable by a new and larger one placed in what is hoped to be a more favourable position.

It was not, however, an easy matter to secure a better position, as the consulting engineer of the bridge company holds very definite views in regard to the retention of all possible gangway space, and he also prohibits any attachment that might by any

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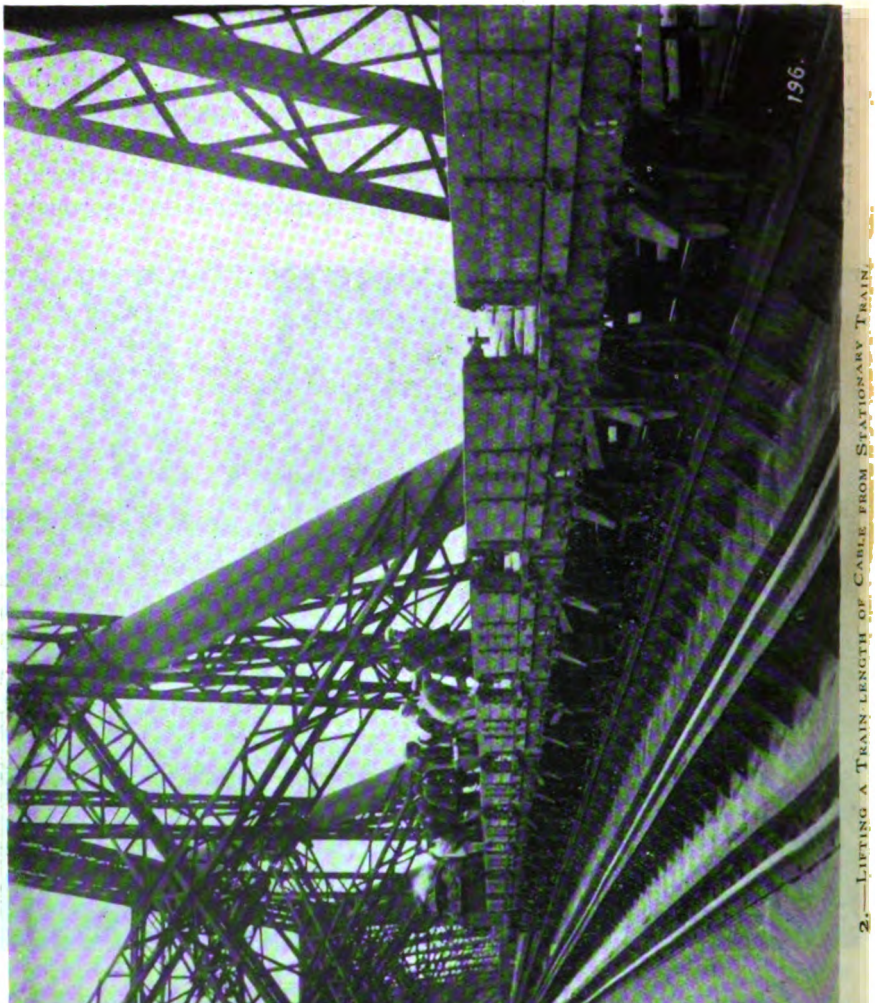
possibility form a catchpoint for any rope or taupaulin that might become loose upon a train passing over the bridge. It was, however,



2.—Lifting a Train length of Cable from Stationary Train.

agreed that we should put the cable on the outer edge of the east footway between the main north and south piers, a distance of 1783 yards, but that at the south viaduct, where the footway is narrower

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than it is in the cantilever section, the cable should go beneath the track decking, where there is a narrow gangway.

The special cable designed for this work is an air-space paper-core cable 68/70 multiple twin, armoured with forty-seven galvanised iron sheathing wires weighing 348 lb. per mile (·16 in. diameter). Between the lead covering and the sheath is a serving of tanned jute yarn about ·15 in. thick, and two servings of similar yarn are laid over the armour in opposite directions. These two servings are each coated with the usual compound (85 per cent. pitch, 12½ per cent. bitumen, and 2½ per cent. resin oil). The total diameter of the cable is about 3 in., and it weighs about 23 tons per mile. The mean wire-to-wire capacity is ·05 mf. per mile.

Work in the nature of cable laying on the bridge can only be effected by closing one track to ordinary traffic, and this is only possible for a few hours of Sunday. The laying and jointing of the previous cable—a much easier job—occupied four Sundays, and for the new cable Mr. Machugh, in his anxiety to economise in this respect, conceived the idea of jointing the main length complete in advance of the laying. This was effected in a siding at Dalmeny upon a train of ten ballast trucks with hinged sides and ends. By this device the closure of one track of the bridge was needed for only two Sundays.

The lead cable jointing was done in the ordinary way, and cable hands from the Submarine Department then completed the sheathing. The plumber's wipes and the sleeve were levelled up by a wrapping of spun yarn, and then a serving of yarn was applied over the whole joint and for a length of about a foot on each side. The strands of armour were then taken from each side alternately over the joint and bound at intervals. Over this was closely served a layer of tarred yarn, and the splice was completed by a wrapping of ozokerited canvas. As a precaution during handling of the cable each joint was securely lashed to a stout batten.

On Sunday, August 15th last, the train of trucks bearing ten lengths of cable in a single piece 1932 yards long was taken on to the bridge by a locomotive. Halting when the rear truck was in line with the south main pier, a complete train length was hoisted on to the footway by a gang of men. The train then proceeded slowly for a train-length while the return length of a "flake" was eased off the trucks on to the ground. Then another train-length was hoisted off the stationary train, and so on until (with an ease that must have cheered the heart of Mr. Crompton, who was representing Mr. Machugh on the work) the whole section was completed without a hitch. 2 gives one view of the process of laying.

3 shows the device adopted to provide for the expansion joint at the ends of the cantilevers and at intermediate points. These

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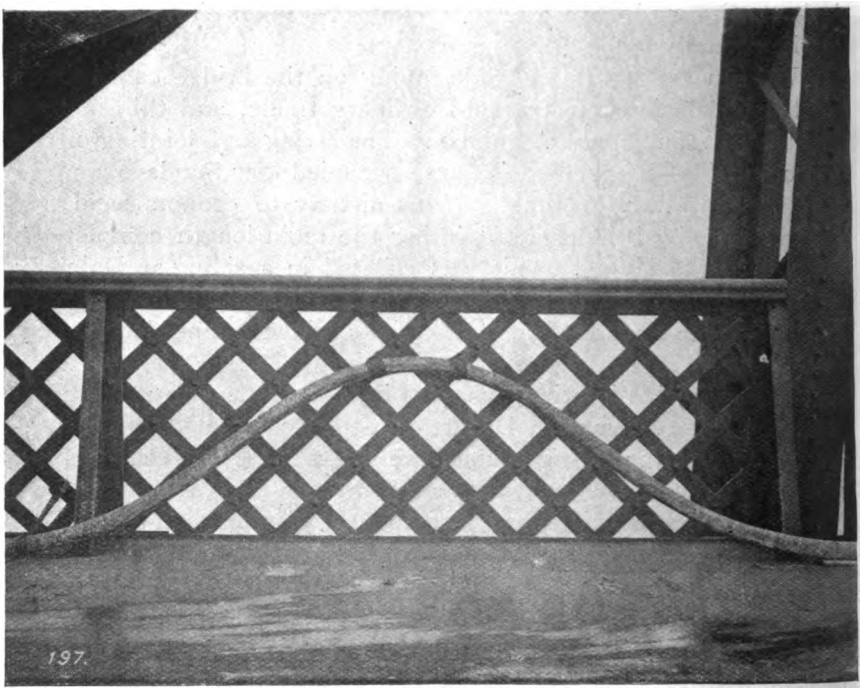
bights in the cable could not be placed exactly at the expansion joints, and on my inspecting the cable later it was evident that there was some danger that they might not readily respond to the contraction and expansion. How real the need is was illustrated by the fact that there were signs of the movement of the bridge having given the cable a horizontal movement of quite an inch to and fro. It was arranged, therefore, to support the cable at those points on a simple form of shoe working on metal rollers in a trough, but on objection of the bridge engineer the alternative of reducing the



3.—"Bight" in new Cable to provide for Expansion of Bridge.

distance of the bight from the bridge joint by transferring the bight to the girder side of the joint has been adopted.

The bights are rested vertically against the lattice parapet of the viaduct which bounds the footpath and are bound thereto at two points of the upper curve, the lower ends being left as free as possible.

Generally the cable is resting on strips of ash about 18 in. long placed about 48 in. centre to centre.

The effect of the vibration caused by passing trains was found to be to give the cable a tendency to move towards the rails—on two occasions it got halfway across the footway in a night—and it was,

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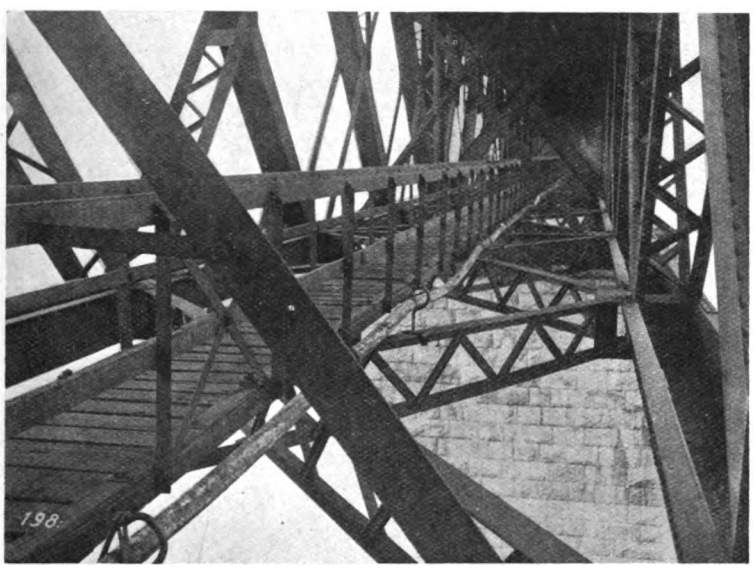
therefore, necessary to lash it with tarred yarn to the base of the parapet at intervals of about 16 ft.

The cable lengths were arranged so that the joints are well clear of the bights, of which there are eight, including the four near the expansion joints of the bridge. Each end of this cantilever section of the cable terminates in a solid plug with G.P. quad tail-pieces.

The four lengths of cable required for the under-deck section of the south viaduct were also placed in position on August 15th. They had to be jointed on the underbridge, as the only way of getting them in position was to pass them through a trap in the decking from drums mounted on railway trucks. Here the cable is slung on



4.—Suspension of Cable on the Underbridge (Dalmeny end).

specially wide raw-hide suspenders from hook-brackets fixed to the trestle-work of the bridge as shown in 4. The natural sag of the cable is ample to provide for the temperature variations in this case. Indeed the cable has to be definitely bound to the suspenders to prevent it from "creeping." The south bank cable-hut is only 30 ft. below the under-deck gangway, and it was therefore possible to carry the cable direct to the hut down the last pier of the approach; but the north end of this 560-yard section is terminated by a solid plug, from which G.P. quads connect to the corresponding solid plug of the main cantilever section on the rail-level above.

The conditions at the other end of the main section are somewhat different, as the north bank test-hut is 100 ft. below the track level (see 5). Further difficulty with the bridge authorities in this

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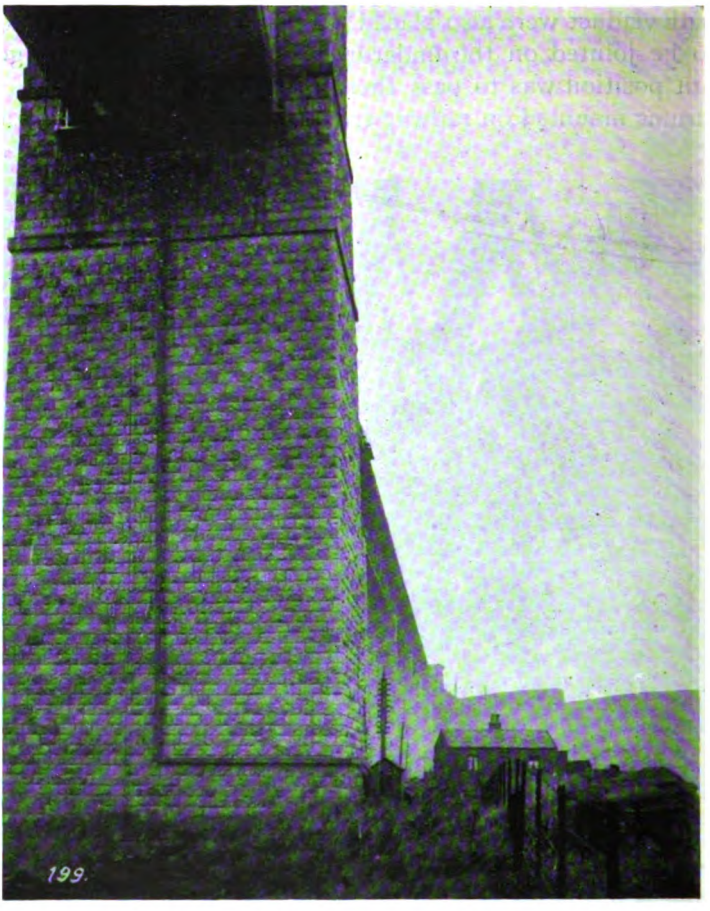
connection was ultimately avoided by deciding to retain the existing length of 42-wire cable, which is carefully cleated inside a wooden trough and has never given any trouble, this to be supplemented by a new cable fixed in the same troughing. As solid joints with G.P. quad tail-pieces are needed in any case this makes a very satisfactory arrangement.



5.—North Queensferry Test Hut showing one Terminal Pole.

It was natural that the operation on the Forth Bridge should attract attention in the press, and one enterprising journal issued the following inspired (?) note :

(Extracted from the 'Edinburgh Evening News,' Monday, August 16th, 1909.)

"Laying a Cable on the Forth Bridge.

"A cable was successfully laid right across the Forth Bridge

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yesterday. The cable is the property of the Post Office and is to take the place of one now on the bridge, which has not given satisfaction. The cable was made on board H.M.S. 'Monarch,' from which ship men were sent to assist in the laying. The cable was on a train of six waggons, and the driver moved slowly across the Bridge while the men laid it down on the footpath on the up line side of the bridge. The weight of the cable was estimated at 300 tons, and there were 68 wires to be taken through it. The probable cost of the cable will be £5000. Mr. Hare, of the Telegraph Superintendent's Department of the North British Railway, was in attendance."

Perhaps some waggish "submarine" had been "yarning!"

The concluding tests were being made and the installation of the new fittings in the huts was nearing completion on October 20th when news came that eight out of the seventeen trunk circuits in the old cable were faulty. The new cable was brought at once into use and saved the situation. LONG MAY IT LIVE.

AN AWKWARD JOB.

THE erection of a tall pole has just been carried out at Carlisle under circumstances which fully justify the above title.

In carrying a new trunk line through the ancient border city it became necessary to erect a 60-ft. pole in a confined back-yard, and we are indebted to Mr. J. W. Ray for the accompanying series of photos showing how this was accomplished. The setting of this pole necessitated the temporary erection of no less than four other poles, viz. a 26-ft., a 32-ft., a 40-ft., and a 50-ft., so that for the provision of this single support five poles in all had to be put up. It is fortunate that such cases are rare, otherwise the strain on the Department's finances would be considerable.

1 shows the front of the house behind which the pole was finally placed. It was necessary to arrange to lift it clear over the roof, and for this purpose two poles, each higher than the roof, were required. The pole shown in 1 is a 50-ft. pole. Its erection was carried out in the usual way by means of a 32-ft. derrick pole, which had to be removed before the stage shown in the photo was reached. The men are engaged in clearing the ropes preparatory to hauling up the 60-ft. pole. A similar derrick pole had been erected on the other side of the house, but this was only a 40-ft., this, unfortunately, being the largest size which could be passed up the covered passage from the street. It had been put in position by the

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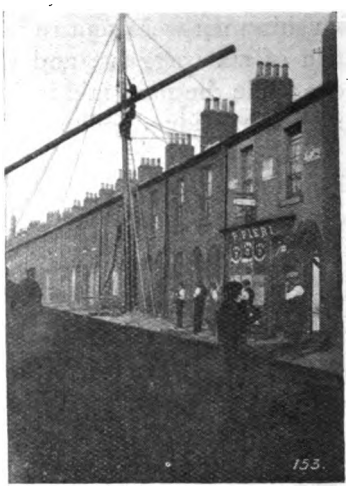
aid of a 26-ft. pole. By means of blocks and tackle the 60-ft. pole was drawn up the 50-ft. derrick until it was high enough to clear

1.—First Temporary Pole.



2.—Pole Ready for Passing over Roof.

the ridge of the roof (as shown in 2). A man is engaged in attaching to the 60-ft. pole the blocks extended from the 40-ft. derrick in the back-yard. The butt end was then swung round, and

3.—Butt end of Pole going over Ridge of Roof.

by pulling on the 40-ft. side and slowly easing away on the 50-ft. side the heavy pole was gradually drawn over the house; and 3 shows the butt end going over the ridge of the roof. 4 was taken

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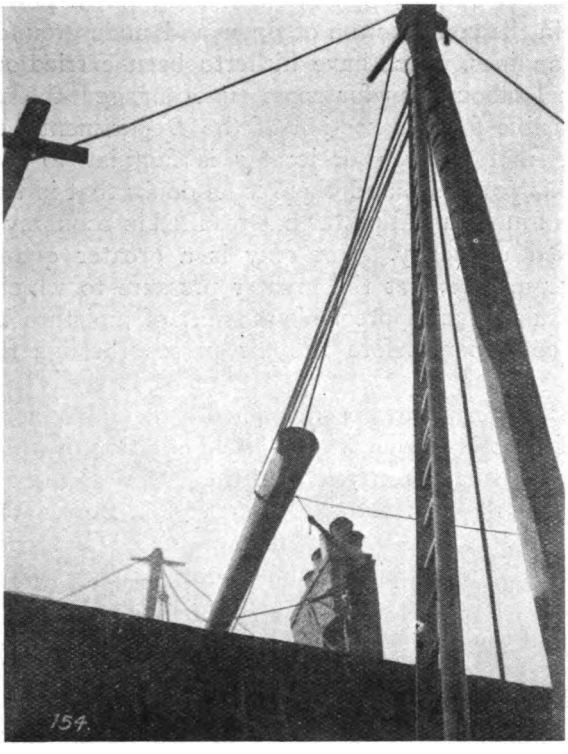
from the back-yard, where the confined space made the photographer's task one of some difficulty. He has, however, succeeded in showing clearly the 60-ft. pole suspended between the two derricks, and the man on the roof guiding the butt end during its aerial flight. The work was carried out in two days, thirteen men being employed on



4.—60-ft. Pole Suspended between two Temporary Poles.

the first day in erecting the derricks and pole, and seven on the second day in removing the derricks and restoring the disturbed surface to its normal condition.

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PORTABLE PETROL-DRIVEN WINCH.

By J. G. HINES.

THE problem of the application of mechanical power to those operations, in the construction of open and underground telegraph and telephone lines, which have hitherto been carried out by combined manual labour, has for some time engaged the attention of those responsible for this section of the Department's engineering work. The motor-driven desiccator is familiar to most of the readers of this JOURNAL, and there is no doubt that in this case the application of mechanical power has resulted in economy of working and increased efficiency. Not only is a greater quantity of air delivered per minute, but the greater pressure to which the air is subjected results in an appreciable amount of moisture being given up in the container, before the air passes through the calcium chloride.

A further step has now been made by the introduction, experimentally, of a motor-driven winch, an illustration of which is given.

This machine has been made to the order of the Engineering Department by Messrs. Lacy Hulbert & Co., Boreas Works, Beddington, Surrey.

It consists of a warping drum about six inches in diameter, which is driven through suitable gearing by a petrol engine. The arrangement of the gearing required careful consideration, as there is a reduction in speed of about 100 to 1 between the engine and the drum. This reduction must be effected noiselessly, and in a small space. The first reduction is effected by means of an epicyclic train, enclosed in a cast-iron case, so constructed that the wheels run continuously in oil. Between this gearing and the warping drum there are two trains of spur gearing.

The engine is a 3 to 3½ h.p. single cylinder petrol engine on the Otto cycle principle, and is very similar to those fitted on the motor desiccators. One end of the main shaft is fitted with a heavy flywheel and the other is coupled to one of the spindles of the epicyclic gear.

The cylinder is cooled with water, which is circulated through the jacket by means of a rotary pump. A large tank and a radiating coil are provided which enable the engine to run several hours without becoming unduly heated. Ignition is effected by an accumulator and high tension coil.

The speed of the pulling rope can be varied from fifteen to twenty-five feet per minute, and excessive speed is prevented by a delicately adjusted governor.

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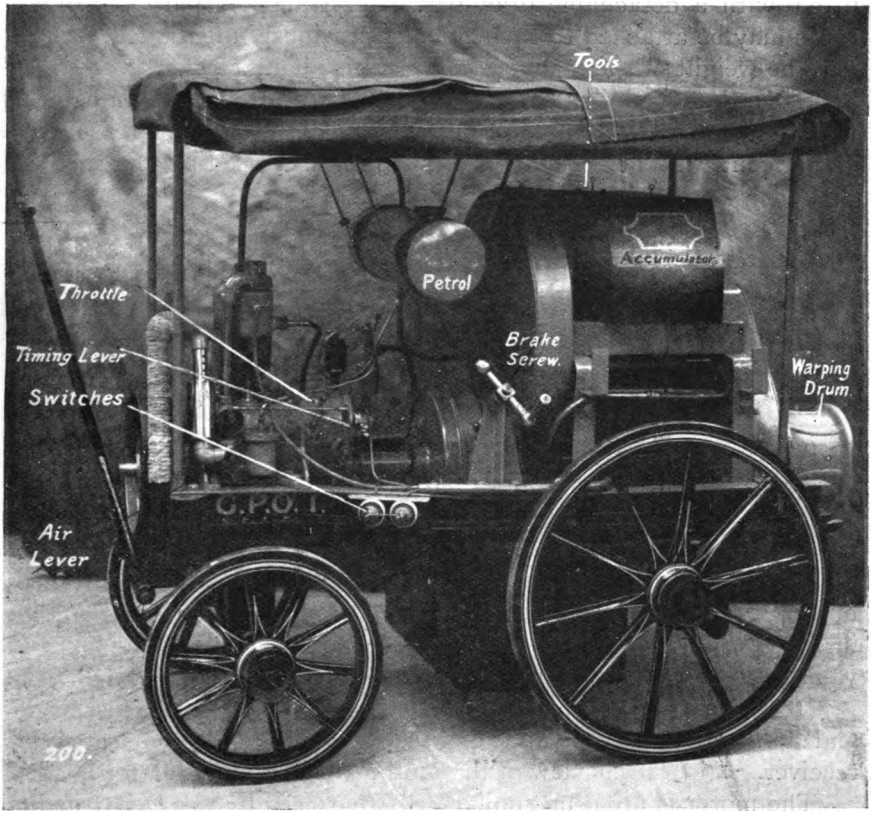
A total stress of two tons can be exerted, but arrangements have been made so that the maximum stress applied to a cable cannot exceed the amount which it is considered safe to apply to that particular cable.

The method of doing this is as follows:

The drum of the epicyclic train is floating, and is surrounded by a brake band, which can be applied by means of the handle shown in



PORTABLE MOTOR-DRIVEN WINCH FOR DRAWING CABLES INTO DUCTS, ETC.

the illustration. If the brake is off and the warping drum is held, the drum of the epicyclic gear is revolved by the planet wheels. When the brake is applied the epicyclic drum stops and the warping drum is set in motion. The handle of the brake can be so adjusted that when the stress on the pulling rope exceeds the amount at which the handle has been set, the epicyclic drum will commence to move and the warping drum will stop.

Strong screw-jacks are provided at the front to remove the weight of the engine from the wheels when the plant is in use, and at the

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other end of the frame there are two stout struts so arranged that not only can they be adjusted to suit inequalities of road surface, but they also resist any pull from a direction parallel to the wheel axles. Four ringbolts are provided so that the winch can be anchored when necessary. Anchoring is not necessary when the pull is vertical.

The engine, gearing, etc., is mounted on a four-wheeled trolley, the frame of which is made of steel channels and stiffened with gussets. The small wheels are attached to a swivelling fore-carriage fitted with a detachable draw-bar. For transport purposes drag-ropes may be attached to the ringbolts previously mentioned.

The weight of the machine complete is about 12 cwt.

Since the winch has been brought into use for drawing in cables, the number of cables dealt with in a given time has increased by 50 per cent. while the cable gang has been decreased by four men.

THE UNDULATOR.

By J. MARTIN.

THE undulator is an instrument of considerable sensitiveness working with a current of ·5 milliampères, and is capable of recording 200, or slightly more, words per minute. Unfortunately its sensitiveness detracts from its usefulness on long telegraph lines, owing to induction and leakage between wire and wire necessitating the use of a low shunt and consequently reducing the sensitiveness of the instrument. Given a wire comparatively clear of disturbance it is a valuable piece of apparatus.

It consists of four parts, viz. the motor, train, undulator head, and bell galvanoscope, and is used in place of the Wheatstone receiver. 1 is a front view of the motor, train, and undulator head.

The motor is fitted up similarly to that used by the Department for the receiver train, but, in addition, it carries a series of shunts, from zero to infinity, which are used for the purpose of increasing or diminishing the sensitiveness of the coils. They are brought in or cut out of circuit by means of an arm. The arrangements are given in 2, which is a top view of the apparatus.

The two coils shown in 3 have a resistance of 800$^{\omega}$ when in series. They are mounted in a frame with a carriage arranged with a right- and left-handed screw thread, so that by operating the thumb-screw the coils are either taken further apart or brought closer together, in the latter case increasing the effect on the armature and consequently the sensitiveness of the instrument.

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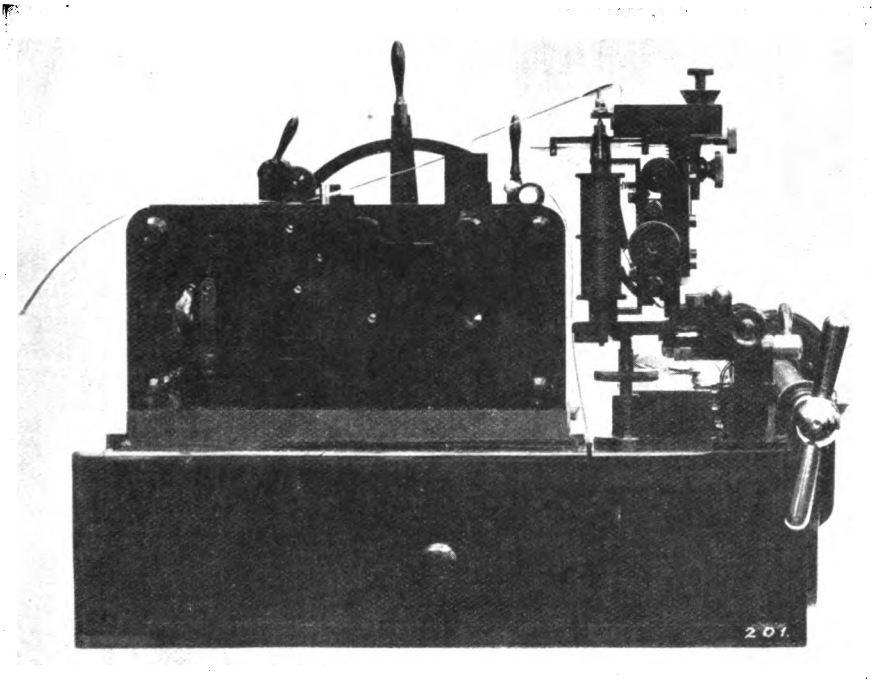
The coils carry pole-pieces faced with a very thin piece of sheet copper to prevent sticking between the pole-pieces and armature when the coils are brought close up.

The armature is made up of two small bar magnets $2\frac{3}{4}$ in. long by $\frac{1}{8}$ in. by $\frac{1}{16}$ in., which are secured to a spindle by means of two narrow copper bands (4). The lower end of the spindle fits into a cup formed at the extremity of a small screw into which is fitted a jewel. The screw is so arranged that the end play of the spindle can be adjusted. The upper part of the spindle passes through the jewelled hole of a



1.—Undulator. Motor, Train, and Undulator Head.

brass arm fixed over the left-hand coil, the extremity of which carries the saddle provided for fixing the syphon (5). The spindle carries a horizontal brass arm, to the end of which is attached two small light brass spiral springs used for the purpose of keeping the armature in a central position between the pole-pieces of the coils. This position is adjusted at the outset, and any further alterations are made by means of a small thumb-screw (shown projecting from the undulator head in 3), which enables the tension on the two springs to be varied, *i. e.* it increases the tension on one and decreases on the other and *vice-versâ*, thus enabling a very fine adjustment to be maintained.

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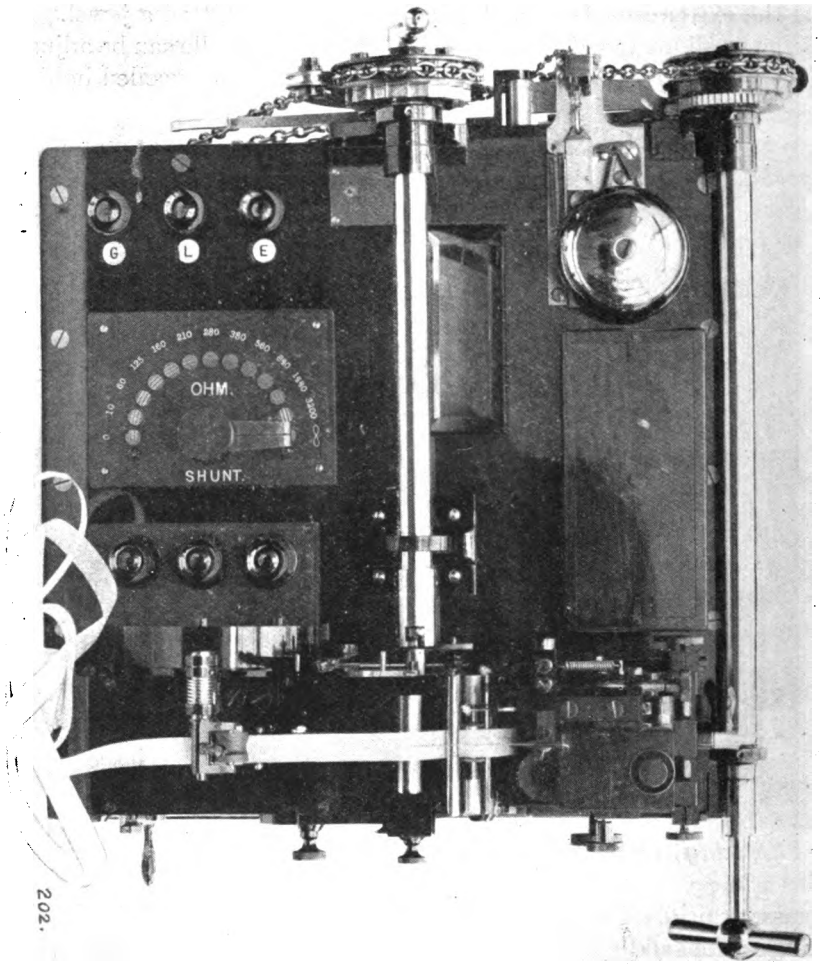
The ink-well is fitted on the frame immediately behind and a little higher than the coils, but slightly lower than the upper end of the spindle. It can be raised or lowered by means of a ratchet operated by a thumb-screw fitted on the front of the undulator head, so that it may be cleared from the syphon when the instrument is



2.—UNDULATOR VIEWED FROM ABOVE.

not in use. Provision is made for its removal altogether for the purpose of being cleaned, etc.

A small brass saddle (1 and 5) is fitted on the upper end of the armature spindle and secured in position by means of a clamping screw. When in position the saddle takes a position of approximately 45° angle with the spindle.

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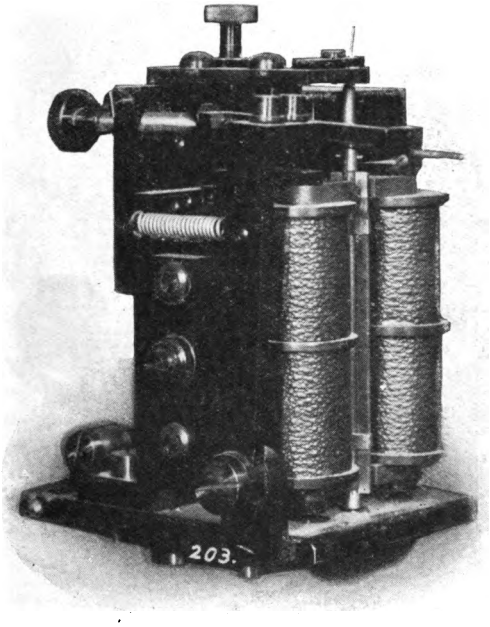
The syphon (1 and 5), made of silver or glass, which varies in length from three to five inches, has its upper end turned about one inch and its lower end about a quarter of an inch nearly at right angles to its length. The upper end dips into the inkwell while the lower end rests lightly upon the slip. The syphon is fixed in the saddle by means of beeswax. It will no doubt be seen that any adjustment of the armature will alter the position of the syphon relative to the slip. Its proper neutral position is in the centre of the slip. The coils at the lower end and at the back are provided with a small



3.—Undulator Electro-magnets.

4.—Undulator Armature of Electro-magnets. (The black lines represent two small Bar Magnets.)

spindle carrying two brass bands so arranged that it can be moved to and fro horizontally through two brass rings, by means of which the coils are joined in series or multiple according to the position of the spindle (5). The frame carrying the coils is fitted on the base of the motor by means of two screws, which fit into cups provided on the brasswork of the carriage and thus form a hinge for raising them. A small crank lever enables the coils and carriage to be slightly raised, so that the syphon may be lifted off the slip when not working. The connections between the coils and the motor base are

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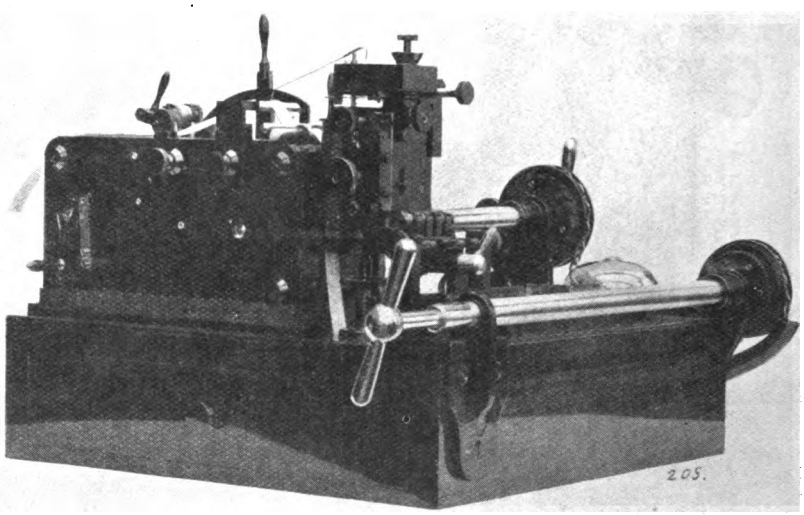
made by means of two flat brass springs. A small micrometer screw fixed on the base of the motor and immediately under the coils (1) is provided for adjusting the pressure of the syphon on the slip.

The train-work is clamped to the motor base and completes the connections between the line, the arm of the shunts, and the coils (2). Provision is made on the upper part of the train for keeping the slip fairly taut and carrying it forward. A small adjustable spindle (1), over which the slip passes and on which the syphon rests, can be moved either horizontally or vertically to meet the varying length of the syphons.

The galvanoscope is simply a galvanometer with contacts and



5.—Undulator. View showing Syphon Printing on Paper Slip.

having a trembler bell in a local circuit for the purpose of making an audible call.

When the apparatus is in a normal position the lower end of the syphon rests on the paper and the upper end dips into the inkwell. A flow of ink is obtained through the tube by capillary action, causing a continuous line on the white slip which is known as the zero line. The flow of the ink can be started by an india-rubber syphon or by running a small piece of smouldering charcoal along and close to the tube. When a marking current passes through the undulator coils the front bar magnet is attracted to the left and the bar magnet at the back of the spindle to the right; this causes the lower end of the syphon to be drawn away from the zero line, and

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6.—Specimen Undulator Slips reproduced full size to show Signals of Different Amplitudes.

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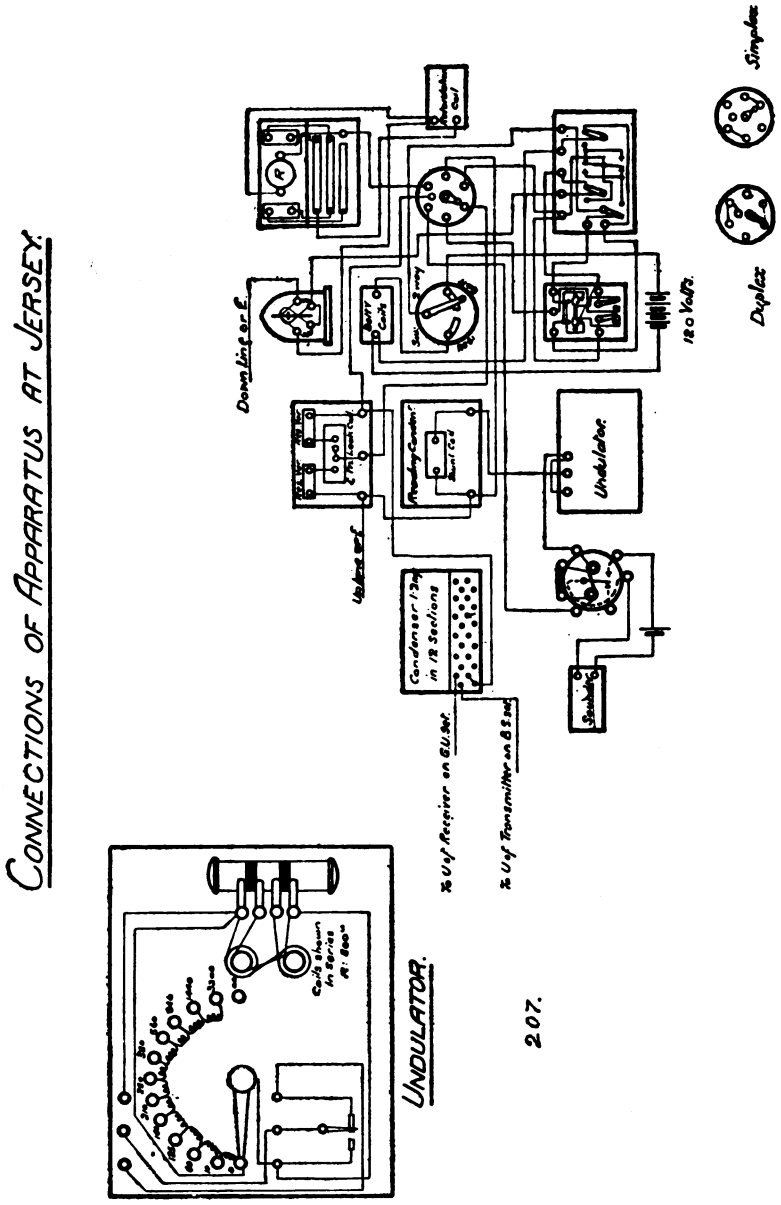
the new position will be maintained so long as a marking current is kept on, but immediately the current is reversed, the syphon returns to the zero line. From this action it will be seen that the new or



7.—London Jersey—Undulator Circuit.

upper intermittent line on the slip forms Morse signals joined to the zero line by lines at right angles to it. If the adjustments are satisfactory, what is known as square top letters are formed, at a low

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speed. As the speed is increased, the tops become more rounded and the amplitude less, until, with a high speed, the signals become undulations with a very small amplitude. Specimen slips are shown in **6**. The amplitude can be increased either by varying the resistance of the shunt, bringing the coils closer to the armature, or reducing the pressure of the syphon on the paper.

The shunts, coils, and connections are shown in the diagram (**7**). The diagram also shows the full connections of the apparatus used on the London–Jersey circuit in the experiments carried out in July, 1908. As it was necessary to have some arrangement for reading by sound when keying, the galvanoscope was replaced by a P.O. standard relay B, wound to a resistance of 500$^{\omega}$. The other connections are similar to those on an ordinary cable bridge circuit.

The undulator is used principally by the Great Northern Telegraph Company, whose operators become so expert that they can read signals of such small undulations that to the ordinary observer they appear almost as straight lines.

MAGNETIC STORMS.

By J. E. TAYLOR, A.M.I.E.E.

MAGNETIC storms, to designate them by their popular title, are exhibitions of electro-magnetic activity on a gigantic scale, which occasionally overwhelm this globe. The immediate effects produced are to disorganise telegraph working by the appearance of stray electric currents on lines operated with an "earth return" and to cause a very considerable fluctuation in the horizontal component of the earth's magnetic field. On the occasion of the magnetic storm of September 25th last, fluctuating currents of, in some cases, three or four times the strength of the working currents, made themselves apparent all over the globe. These currents maintained a constant direction of flow for prolonged periods (fifteen or twenty minutes being quite usual), with occasional reversals of direction, at irregular intervals throughout the period of duration of the storm. In this country the phenomenon commenced at 11.40 a.m. and did not completely pass off until about 2 a.m. on the following day. Lines from London to Newcastle-on-Tyne, London to Penzance, London to North Walsham Repeater Station, and to the repeater stations at Llanfair and Nevin, appear to have been specially strongly affected. Measurements taken at Nevin on a London wire of about 1700 ohms resistance showed currents up to 120 milliampères. As compared with the previous storm of October 31st,

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1903, the recent storm was much the more intense, though the duration was about the same.

At all times there exist on earthed telegraph wires fluctuating earth currents of a mild character, having roughly defined periods of maximum and minimum activity corresponding with the hours of daylight and darkness and with the seasons of the year, but between these ever-present disturbances and visitations such as that referred to above, a strong line of demarcation is drawn. The primary cause is possibly the same in each, but while one is probably a direct effect the other is more likely an indirect or secondary effect.

Considering for a moment the electro-motive force necessary to produce an earth current of roughly 100 milliampères on a London-Penzance circuit of, say, 2000 ohms resistance, it is evident that a difference of potential of about 200 volts is maintained between two points on the earth's surface about 300 miles apart! The earth being a conductor, this must involve stupendous electric currents circulating in the ground. In the case of the oceans, where the conductivity is far greater, it cannot be an exaggeration to say that millions of ampères of current are circulating during a magnetic storm of moderate intensity.

It is usual to connect together the phenomena of sun-spots, earth currents, and the aurora borealis. Not infrequently also volcanic eruptions and earthquakes are cited as possible causes of magnetic storms. At periods of magnetic storms, exceptional auroral activity is always apparent. Periods of exceptional sun-spot activity are not, however, by any means invariably periods of magnetic storms, though the converse appears to hold.

It may occur to many to ask why it should be necessary to seek an explanation outside the realm of the earth itself. That it is necessary, however, is fairly evident from elementary considerations. An electric circuit must always be closed or completed on itself. If the circuit were confined to the earth the currents could only be produced by electro-magnetic or electrostatic induction. But to maintain even weak currents continuously in one direction for prolonged periods would involve the continuous building up of electrostatic or electro-magnetic fields of force of an intensity far beyond anything possible in terrestrial conditions. Even assuming a condenser effect between the rarefied upper regions of the atmosphere and the surface of the earth, the capacity would only be such that it would be charged or discharged up to or from the disruptive point of the air in a small fraction of a second, by a flow of current infinitely smaller than that which circulates in the earth's crust during a magnetic storm. Equally untenable are the assumptions that anything in the nature of electro-magnetic induction is involved, whether it be held to be caused by telegraph wires cutting a

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magnetic field due to changes in terrestrial magnetism, or a projection of a magnetic field from the sun or other cosmic body. In other words there can be no doubt that an effect of conduction is concerned, and that both in view of its magnitude and sustained character it is of extra-terrestrial origin. Latter-day researches on effects occurring in high vacua under the stimulus of electric stress prove the possibility of the convective passage of large electrical currents in a medium which is otherwise perfectly non-conductive, by myriads of corpuscles each carrying its own quota of inseparable and invariable electrical charge and capable of moving with inconceivable rapidity through empty space. Such considerations led Fitzgerald, Birkeland, Arrhenius, and others to surmise that the phenomena of the aurora borealis and magnetic storms were due to streams of corpuscles in space occasionally entering the earth's atmosphere and being diverted towards the poles under the influence of the earth's magnetic field. The researches of Sir J. J. Thomson, and numerous other workers, bearing on the mechanism of electrical conduction in gases and in vacuum, combined with researches on radio-activity, not only shed much light on fundamental processes of electrical conduction, but have afforded a glimmering of the constitution of matter itself and its connection with the basic ether of space.

The most vital point in relation to the subject of magnetic storms, however, is the discovery that vacuous space can be traversed by electrical currents of considerable density, measurable in ampères per square centimetre of cross section, provided that a sufficient supply of the carriers variously known as corpuscles, electrons or disintegrated atoms of matter (not matter itself) can be brought into service. In these circumstances vacuous space becomes a very fair electrical conductor instead of a perfect insulator. Hence it is conceivable that the earth may be enveloped in the stream-path of an electric circuit in space. That such an event does occasionally occur appears to be the only tenable enplanation of so-called magnetic storm visitations.

In a communication to the 'Electrician' under date January 11th, 1901, Professor Elihu Thomson gives the outlines of a remarkable theory of magnetic storms, very complete and reasonable in its assumptions, though a little too "materialistic," which does not appear to have attracted the attention it deserves. He points to the probable electrical agency whereby the sun's corona and coronal streams are formed in virtue of continually augmented electrical repulsion of ultra-fine particles of matter due to shrinkage of an initially electrified nebulous mass. He further points out that the luminous corona is probably but a small part of the whole, and that invisible (because non-luminous) coronal streams may spread far away out into space. In the passage of the earth through such an

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invisible streamer, the phenomena of auroræ and magnetic storms would find adequate explanation. Some of the phenomena of comets' tails are also explainable on the same assumption.

The weak point in this theory is, of course, the extravagant expenditure of matter which would be involved in maintaining continuously the tremendous electrical effects concerned. But substitute for electrified material particles, disintegrated matter or corpuscles, and combine with the knowledge concerning the vast internal energy of atoms, rendered evident by recent researches in radio-activity and kindred studies, and the difficulty disappears. This internal energy is liberated in the corpuscular state, and if the invisible corona consist of streams of such corpuscles journeying, with tremendous velocity, from and to the parent solar body—an electrical atmosphere in which, perhaps, the whole solar system is immersed—occasional electrical displays on this globe are not surprising. Another difficulty may, at first sight, arise from this assumption, viz. that if the earth is always immersed in such an atmosphere there should be continuous auroræ and magnetic storms. But if it be considered that in such circumstances the earth must always possess a high negative charge, it will exert sufficient electrical repulsion on the corpuscular streams to divert them to a sufficient distance away and thus screen itself from their direct effect. It would then only be affected by exceptional increases in the density and potential gradients of the corpuscular streams in its neighbourhood.

In support of the view of a corpuscular atmosphere it is known that hot bodies are capable of ionising gases, and that flames of all kinds contain and emit free corpuscles, though their presence is often only indirectly observed through ionisation by collision with the gaseous molecules. It is therefore reasonable to assume that in an intensely hot body like the sun the emission of corpuscles may be extremely great. It is also known that various substances can be made to emit corpuscles by the direct effect of light. In photo-electric effects it would appear that sufficiently intense luminous vibrations are capable of exciting corpuscles to which they may be attuned, to a degree which determines the dissociation of those corpuscles from the main system constituting an atom of matter. In the intense luminous vibrations at the surface of the sun the effect may be greatly magnified. The peculiar phenomena associated with comets coming within the range of influence of the sun, the rapid development of tails, the repulsion of the tails, which are always directed away from the sun, and are therefore in front when the comet is leaving, the apparent development of intense heat in the nucleus and self-luminosity which they do not possess when at great distances away, all appear to argue in favour of such an atmosphere. The late Professor Fitzgerald showed conclusively that repulsion by light

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from the sun is insufficient to account for comets' tails being directed away from the sun.

Following the nebular hypothesis, instead of the heat of the sun causing atomic disintegration and emission of corpuscles, it naturally occurs that the reverse may be the case, *i.e.* the solar nucleus may be in a certain stage of formation, matter itself may be in process of formation by the slow agglomeration of corpuscles originally composing a vast nebular system. It is to be expected in such a case that highly attenuated gases would first be formed, and these would become self-luminous by reason of the electrical currents traversing them. As the action progressed the solid nucleus would form at a later stage. This, however, is at present but pure speculation.

The foregoing surmises may perhaps have an additional interest lent to them in view of the approach of Halley's comet into regions near the sun—an approach which may throw more light on interplanetary conditions, and indirectly on the cause of magnetic storms.

A SNOWSTORM BREAKDOWN.

By Hy. Kitchen (N. District).

During the night of December 6th, a heavy snowstorm visited the north-west of Durham. Unlike the usual storms which visit these parts it was not accompanied by a high wind. The consistency of the snow was such that it adhered to the wires until they became ropes of snow. Three hours after the commencement of the storm, light-gauge wires at Annfield Plain and Consett were so burdened that they touched the ground in places. As may be expected most of the wires broke in these sections. In this locality an old 22-ft. light pole, carrying six wires, broke at the ground line.

At Stocksfield a 45-ft. stout pole, carrying 46 wires on 96-in. arms, broke 8 ft. from the top, and fell across the footbridge of the railway station. Luckily this happened about 3 a.m. and no one was hurt. 1 shows the broken pole. The fracture commences at a filled-up arm notch, and passes through a knot 2 ft. lower to the opposite side of the pole. The pole is also severely strained at a point 9 ft. from the ground line.

The sudden stress thrown on the next pole caused it to split in a remarkable manner. It will be seen from the photographs (2 and 3) that the fracture extends from the bottom arm notch to the ground line. The pole in this case is a 36-ft. stout, and is excellent timber in every way, free from knots of any magnitude and perfectly

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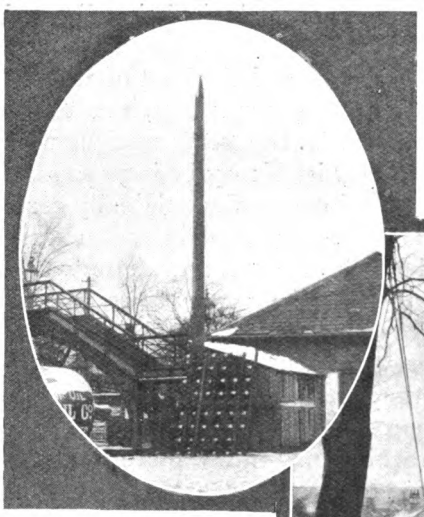
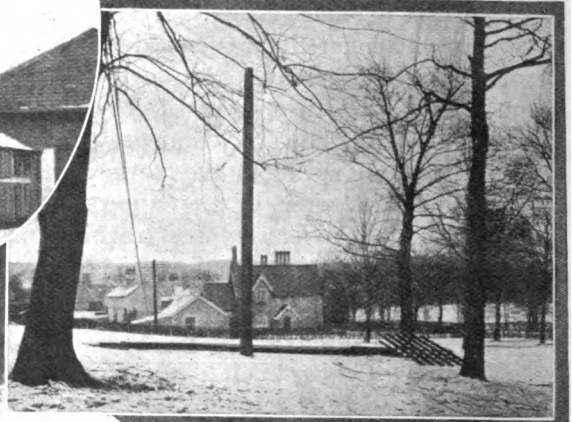


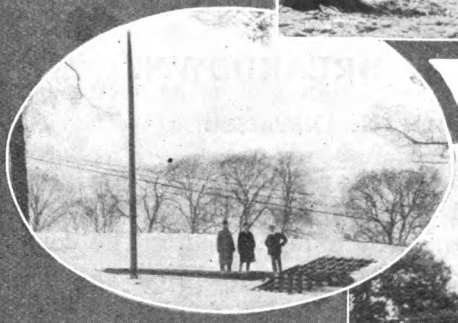
1.—Top broken off Pole at Stocksfield Station.

1



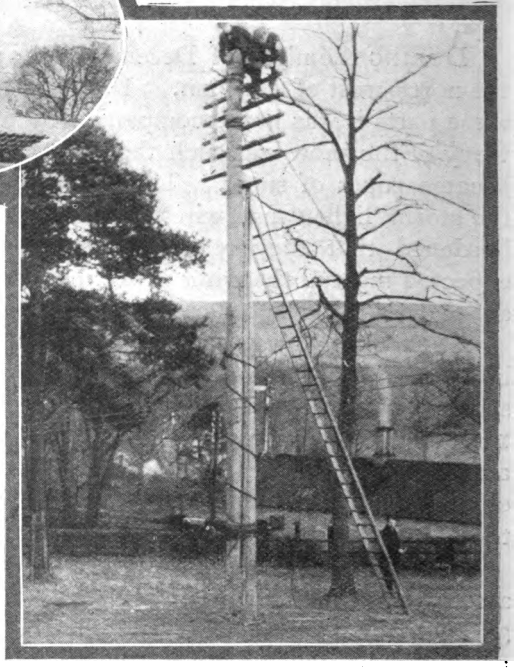
2

2.—Adjoining Pole Split from the Top to the Bottom.



3

3.—Split Pole and Snow-Rope Wires.



4

4.—Split Pole Temporarily Repaired by Splicing.

Snowstorm Damage at Stocksfield, Northumberland, December 6th, 1909.

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straight in the grain. The adjacent pole (shown in the photograph carrying the interruption cables) is the Post Office terminal pole, and shows signs of strain, but fortunately it stood up against the shock.

The service was partly restored by interruption cables and partly by open wires. To facilitate this work Mr. Wyatt, the construction engineer, rigged up a jury mast with the two portions of the split pole as shown in the photo (4) taken a day later. The splice was a rough one owing to the impossibility of putting the fractured portions in contact. The top was lashed with 400 lb. G.I. wire, and a 2 in. rope used from the middle to the bottom. This temporary structure was made secure by guy ropes attached to adjacent trees and answered the immediate requirements admirably.

The experience gained during this snowstorm, shows that the old Britannia joint with the turned-up ends is stronger than the new joint. The majority of the breakages occurred at the joints, and approximately 75 per cent. of these were due to the wires drawing at the soldered connection. A number of the broken wires indicated that too much heat had been applied during the soldering operations.

NOTES AND COMMENTS.

Glasgow's New Telephone Exchange.

We have to thank Mr. J. W. Turner, of the Engineer-in-Chief's Office, and we feel sure our readers will be in hearty accord with us, for the very complete description of the new Central Telephone Exchange at Glasgow which he has enabled us to place before our readers in the present issue. It is the largest common-battery exchange of British manufacture which has up to the present been installed in this country. It will be remembered that the type of speaking circuit employed at Glasgow by the Peel Conner Co., which is based upon that of the Stromberg Carlson and General Electric Companies, was analysed, and its efficiency compared with that of other systems, in an article by Mr. Ramsay which appeared in our first number.

The Paris Congress, 1910.

We learn that the following topics have been singled out for special discussion at the Second International Congress of Telegraph and Telephone Engineers, to be held in Paris next year:

(1) Manual *versus* automatic systems of telephone working.

(2) (*a*) Simplification of telephone circuits; (*b*) selection of frequency and secondary potential (for purposes of theoretical investigation) with a view to facilitating the approach of the tele-

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phone current to the Sine wave-form ; (*c*) the circumstances conditioning the adaptability of telephone apparatus to the lines, induction coils, microphone resistance, etc.

(3) Precautions to be taken for the avoidance of mutual disturbance in the case of power circuits running in close proximity to telegraph and telephone lines.

(4) Telephony between places at great distances from each other. Construction of cables for long-distance use, relays, combination of aërial lines with cables.

(5) Wooden poles—new process for impregnation and preservation—and procedure described from actual practice as to staying and strutting.

(6) Party lines and selective calling upon telegraph and telephone lines.

(7) Telegraph systems for heavy traffic. Multiple type-printing telegraphs and the Mercadier system.

German Technical Literature.

The editors of the '*Z*eitschrift für Schwachstromtechnik,' published monthly, have kindly offered to supply their journal to members of the I.P.O.E.E. at 6*s*. per annum, that is, at half the usual price. Members who may wish to avail themselves of this offer should write direct to '*Z*eitschrift für Schwachstromtechnik,' Jägerstrasse 17, München.

Snowstorm Damages.

The dangerous effects which may result from the action of snowstorms upon aërial lines are strikingly illustrated in the photographs sent in by Mr. Geo. A. Peck, which we reproduce on page 327. The pole shown in the upper picture stood at an angle and broke owing to the stays giving way. The pole in the bottom picture broke owing to the collapse of its neighbour; all the wires and cables fell across the Middlesboro and Stockton Electric Tramway, and the tramway service was interrupted for the greater part of a day. The damaged plant in this case belonged to the National Telephone Company. From another series of photographs, however, it will be noted that a similar experience has befallen the Department at Stocksfield, Northumberland. This is a very beautiful village in the valley of the upper Tyne, but it has quite a reputation for wet snowstorms. In the last year of the last century a snowstorm of the wet and clinging type occurred at this point, with the result that some 400 lb. iron wires, running on short poles on the railway company's line, were weighed down until they touched the ground in every span for about a mile. No actual breakage occurred, but of course the circuits—some of which were Departmental telegraphs—were unworkable.

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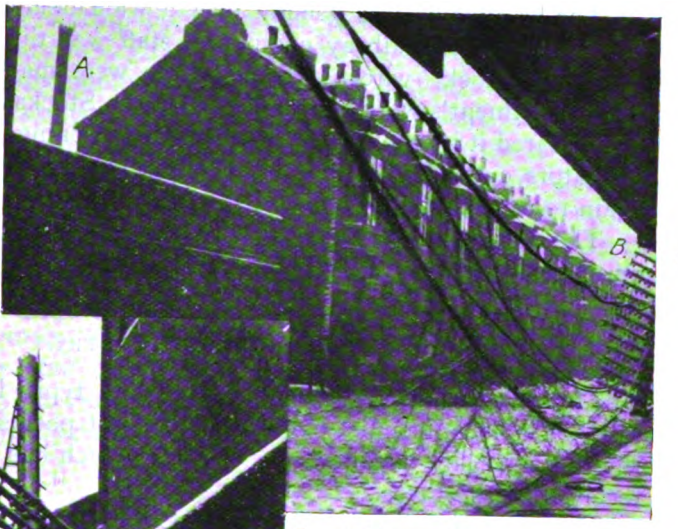
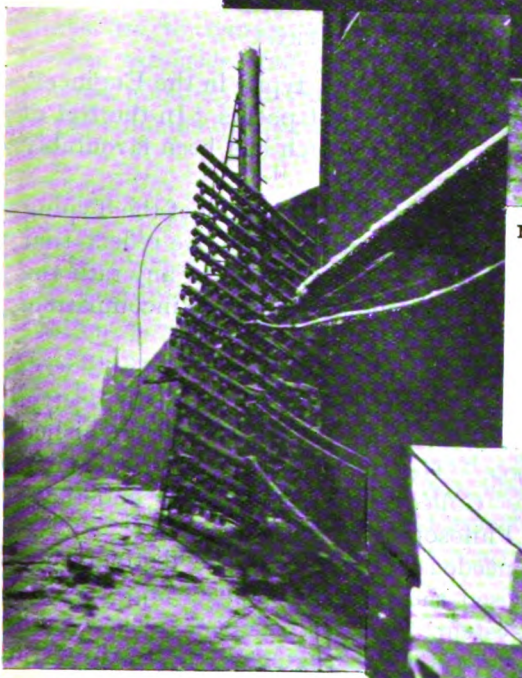


1

1.—A. Pole from which the Top, with 18 Arms and about 200 Wires (40 lb. bronze) has parted.

1.—B. Upper Portion of A. after it has been pulled over the end House, damaging Roof and Chimney-stack.

2



2.—Nearer view of B. It is upside down and held in position by Aërial Cables and their Suspenders.

3

3.—Adjoining Pole broken off at top and held against Houses (12 feet from pole) by Wires and Cables.

Middlesboro, November 15th, 1909. Snowstorm Damages.

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The breakdown was general over a wide area, and naturally all the energy of the railway company's staff was directed to making good the "block" wires. Arrangements were made for a gang of the Department's workmen to deal with the Stocksfield trouble, and they cleared it by the simple method of loosening the wires at the insulators, cutting about four yards out of each, and pulling them up again to the proper tension.

The diminution in gauge which accompanied this process is not on record.

Engineering and Poetry.

Mr. F. S. Flint, a shorthand writer and typist in the Engineer-in-Chief's office, has just published a book of poems, 'In the Net of the Stars' (Elkin Matthews, 2*s*. 6*d*. net), which has been favourably received by the Press.

When we recall that Mr. Sivori Levey, principal of the Typing Section, is also known to fame for a similar reason, we reflect that if poetry and engineering are not often associated, at any rate the constant perusal of engineering correspondence is not incompatible with the cultivation of the Poetic Muse.

It is curious to note that the close association of music with engineering is much more frequent than is the case with poetry. We recall the case of William Pole, F.R.S., a distinguished engineer, who died in 1900. He occupied the chair of Civil Engineering at University College for eight years, and later published a book on the 'Philosophy of Music.'

If another example is needed we may cite the distinguished electrical engineer who advised the London County Council at the inception of the tramway system. He has occupied in succession the Presidencies of the Institute of Civil Engineers, the Institute of Mechanical Engineers, and the Royal Society of Musicians.

Staff Changes.

The list of promotions and transfers is this quarter unusually lengthy. We note with pleasure that it contains the names of many officers promoted from the moribund Sub-Engineers' Class, and we are glad to know that, to some extent, they have been compensated for the lengthy period they have been kept in waiting by the ante-dating of their appointments.

Two positions, regarded by many as carrying the blue ribbons of the telephones and telegraphs respectively, have seen changes in their holders. Mr. H. P. Brown has succeeded Mr. J. H. Stanhope as Engineer-in-Charge of the Combined Central, City, and Trunk

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Exchanges of the Metropolis, while Mr. Jas. Fraser has succeeded Mr. P. Mulligan at the C.T.O. Mr. Stanhope, promoted to A.S.E., has gone to the Metropolitan South District, and Mr. Mulligan has departed to fill a similar position at Nottingham, where he will take charge of a *sub-district* under Birmingham. The latter is a new departure. The dismemberment of the North Midland district, referred to elsewhere in connection with Mr. West's retirement, had passed into an old story, when suddenly, in deference, it is understood, to the wishes of the Nottingham Council, new plans were made, and the *sub-district* emerged from the great unknown. Ten clerks are to remain at Nottingham. Persistent rumours as to further extensive staff changes, as part of a great reorganisation scheme, abound; but no reliable information is yet available—except in the columns of the daily press.

The Society of Post Office Engineers.

The Society of Post Office Engineers, which gave birth to the Institution of Post Office Electrical Engineers, has given another proof of its virility by issuing on December 15th a new journal under the title of 'The Post Office Engineer.' It will appear monthly, and its avowed object is to circulate news of special interest to the various classes of engineers, and generally to further the interests of the Society and its members. Every medium for bringing engineers into closer touch with each other tends to better understanding and agreement, and is for the general good. We give our contemporary hearty welcome.

INSTITUTION NOTES.

COUNCIL NOTES.

A MEETING of the Council of the Institution was held at Manchester on October 5th and 6th, 1909, under the Chairmanship of Mr. A. J. Stubbs. A large volume of important business was dealt with during the sessions, and an additional interest was given to the proceedings by reason of the fact that a meeting of the Manchester Local Centre was held, coincident with the visit of the Council, and an opportunity given to members to discuss with the Executive the progress and development of the Institution.

We are pleased to note an extension of the principle of visiting the various Local Centre headquarters, and it is hoped that the

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missionary spirit exhibited by the Council will result in an augmentation to the roll of membership, particularly on the clerical side.

The interchange of views on the work of the Institution will tend to strengthen the bonds of good fellowship already existing between the Local Centres and the parent body. In this connection it is interesting to note that the Council visited Edinburgh and Glasgow on December 8th and 9th respectively, when Local Centre meetings were arranged, and opportunities for intercourse given between the Executive and the local branches.

Resignation of Members of the Clerical Force.

In response to the Council's invitation to the Committees of Centres for suggestions as to the best means of rendering the Institution more attractive to members of the Clerical Staff, replies have been received from the following Local Centres, viz.: Metropolitan, Eastern, North-Eastern, North Wales, and Scotland East centres respectively. The communications contained valuable hints on the subject and these are receiving the careful consideration of the Council, who are endeavouring to deal with the matter in a thoroughly business-like manner. Certain negotiations are at present in progress which will have an important bearing on the subject, and it is hoped that the question will be ripe for publication in the next issue of the Journal.

Assistance to Members in the Preparation for Examinations.

The Committee appointed to deal with this matter reported that, after considerable labour and collecting of material—work which, owing to exceptional circumstances, had been prosecuted with difficulty—the task had proved of greater magnitude than was at first anticipated, and the progress made was not such as justified the Committee in holding out hopes of its successful completion.

The Council received the Committee's recommendation with regret, but for the most part agreed that the conclusion arrived at was a wise one, and that it was best in the circumstances to abandon the issue of a compilation which the Council foresaw would be experimental in its scope and usefulness, and be attended with risk of misinterpretation.

The following resolution was unanimously carried: "That in place of issuing the proposed notes, a short list of books likely to prove useful be prepared and issued, the list to be accompanied by an explanatory letter from the Council."

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Membership.

The following statement of membership was presented :

Number on roll March 31st, 1909		828
By death and retirement	9	
By resignation	58	
	—	67
Number on roll April 1st, 1909		761
New members—		
Home	26	
Colonial	10	
Foreign	2	
	—	38
Number on roll October 2nd, 1909 . .		799

Irish and S.W. Centre Arrangements.

The Secretary stated that the transfer was still in progress, and that matters were not sufficiently far advanced to permit of the election of a local committee or the preparation of a programme. Sergt. Willis, the Local Secretary, Ireland Centre, had, however, written expressing his opinion that so far as the Irish Centre was concerned he hoped to be in a position to commence operations in the course of a month or six weeks' time.

Revision of Distribution Arrangements of Technical Periodicals.

The Library Committee reported that, as a result of their investigations, a new scheme of distribution had been framed which would effect a yearly saving of nearly £60.

The Council unanimously agreed to accept the report, and the Committee was empowered to carry out the proposed rearrangement, commencing with the November issues.

Colonial and Foreign Membership Applications.

The Secretary reported that applications for admission to Corresponding Membership of the Institution had been received from the following gentlemen. In each case the Council authorised the acceptance of the application.

Colonial :

Mr. G. H. Eyre, Postmaster-General, Rhodesia.

Mr. T. H. Watson, Engineer, Johannesburg.

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Mr. P. B. Lawson, Director of Government Telegraphs, Southern Nigeria.

Mr. J. E. Williams, Assistant Engineer, Pietermaritzburg.

Foreign :

Senor Carlos Solor Montes, Telephone Superintendent, Cuba.

An application from Mr. D. P. Reid has also been provisionally accepted.

Departmental Grant; Council's Suggestion re Expenditure.

With reference to the suggestion made at the previous Council Meeting, that inquiries be made of the London School of Economics as to a course of lectures on "Economics," the Chairman stated that he had made inquiry on the subject, but without practical result.

It was suggested that a course of lectures be arranged on the Specifications issued by the Department, and the tests applied to the various classes of materials used in the Department's engineering work.

The Chairman stated that the question of the provision of a series of notes or instructions on the testing of materials was already projected by the Engineer-in-Chief, and after some discussion it was resolved: "That the question under discussion be referred to a Committee of three to report on the subject, such Committee to include one Member of the Clerical Staff." The proposition was unanimously agreed to.

The following Members of Council were unanimously chosen to constitute the Committee: Messrs. Kempe, Martin, and Barrett.

Promotion of Mr. Atkinson.

The Chairman announced the promotion of Mr. Atkinson to a First Class Engineership, and drew attention to the necessity of appointing a successor on the Council to represent the Second Class Metropolitan Engineers.

A hearty vote of thanks was accorded to Mr. Atkinson for his lengthy and valued services to the Institution, and the Council expressed their sense of appreciation and gratitude for his zealous labours.

Mr. Atkinson having been elected to the Council unopposed, it was resolved that an election be proceeded with for his successor.

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LIBRARY NOTES.

THE following books have been added to the Library, and are available for the use of members:

No.

71. 'Electrical Calculations.' Sloane.
72. 'Induction Coils.' Collins.
73. 'Railway Stores Management.' Kempthorne.
75. 'Building Superintendence.' Clark.
76. 'Photography for Students.' Derr.
77. 'Principles of Physics.' Daniels.
78. 'Dynamo Design.' Hobart.
79. 'Measurement of Electrical Resistance.' Price.
80. 'Book-keeping, Commercial.' Fieldhouse.

Offers are still invited for the purchase of the following books:

'Sound.' Tyndall.

'Secondary Batteries.' Wade.

The copies are in first-class condition.

Offers should be forwarded to The Librarian, Room 11A, G.P.O. West, London, E.C.

LOCAL CENTRE NOTES.*

METROPOLITAN CENTRE.

MEETINGS.

THE first of the monthly meetings of the Metropolitan Centre for the Session 1909–10 was that of October 11th, when the members were favoured with a lecture, by Mr. H. R. Kempe, on "Pneumatics." Mr. Kempe reviewed the progress and development of the pneumatic tube system of propulsion, from the early atmospheric railway of 1845, to the present day adaptation of the principles in the familiar pneumatic carrier tube of the Telegraph Department of the British Post Office. The lecture was followed by an interesting discussion.

On November 8th Mr. J. W. Atkinson presented a paper on "Estimates, Costs, and Records," in the course of which many suggestions of a novel character were brought forward for revising procedure under the several heads. In the main the debate on this paper centred round the oft-discussed problem of records.

Both meetings, which were well attended, were held in the lecture theatre of the Northampton Polytechnic Institute, Clerkenwell, under the presidency of Mr. A. Moir, Chairman of the Metropolitan Centre. The hall has proved to be eminently suitable for the lectures, and has been engaged by the Committee for the remainder of the Session.

* These notes only include events up to December 13th, 1909.

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A VERY interesting paper was read on the evening of December 13th, before the Society of Post Office Engineers, by Mr. J. Sinnott (Assistant Superintending Engineer), on the subject of "Municipal Fire Alarms."

Mr. Sinnott mentioned that the first application of the electric telegraph to the transmission of fire alarms was made in Berlin in 1849, and that until 1880 there was no system of street fire alarms in London, or, in fact, in any other town in Great Britain. In the year 1886 Mr. A. C. Brown invented the system which is still employed by the London County Council. In the year 1886 347 street-call points were installed, and at present 1317 were in use. For the year 1908 the Chief Officer of the London Fire Brigade reported that of the 5811 calls received, 3236 were given by the street alarm boxes, 1949 by persons calling at the fire station, 477 by telephone exchange subscribers, 62 by police and salvage corps, 52 by private fire telephones, 12 by automatic alarm systems, and 23 by public telephone call offices. Out of the 3236 street fire calls, 530 were false alarms due to electrical faults. These false alarms were very difficult to deal with, but the Engineer-in-Chief to the Post Office had suggested the use of some special auxiliary apparatus for the purpose, which had been tried experimentally in connection with Islington Fire Station. The results obtained had been so satisfactory that the County Council had decided to alter similarly the whole of the London system.

Mr. Sinnott then described in detail the systems of fire telegraphy employed in many countries, making special mention of the "Gamewell" system in extensive use in the United States.

In concluding, he expressed the hope that the Post Office Engineers would always bear in mind the great importance of maintaining the fire-alarm systems entrusted to their care at the highest possible standard of efficiency, remembering that the prompt transmission of a call might mean the saving of human lives, of which 100 are, according to official returns, annually lost through fire in the County of London.

The paper constitutes a very valuable contribution on a subject which has, up to the present, received very little attention in current technical literature. It is hoped that it will be added to the list of the Institute's publications.

VISITS.

ON November 22nd a visit of a most interesting and instructive nature was paid to the works of the Western Electric Company at North Woolwich. Here were seen, under full working conditions, the manufacture, amongst other items, of the articles indispensable to the full equipment of the modern telephone system. A subject of particular interest was the manufacture of

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air-space lead-covered cables, from the initial stages of spooling the thread and cutting the insulating paper, to the finished lengths, sheathed, desiccated and tested ready for shipment and delivery. The attention of many of the visitors was specially rivetted on the practical demonstrations of the searching insulation tests applied to high-tension electric light and power cables.

The manufacture of the various items of apparatus requisite for the up-to-date telephone switchboard was in evidence in several shops, and incidentally the progressive stages in the manufacture of condensers evoked a deal of interest.

The processes of nickelling, lacquering, and enamelling were viewed in turn. These and many other auxiliary operations impressed the visitors with the wealth of organisation required of the proprietors and *entrepreneurs* of this branch of industry.

Before the members dispersed Mr. Moir proposed a very hearty vote of thanks to Messrs. Pingree, Pease, Turney, and Williamson, and the other gentlemen who had so kindly conducted the several groups of our large party round the Company's works. This was ably seconded by Mr. Tandy, and, needless to say, carried unanimously. The thanks of the members are also to be recorded to Mr. Kingsbury, the General Manager of the Company, for according permission for the visit to be made.

At the time of going to press the Committee announce that a visit has been arranged for December 18th to the new General Post Office premises known as the "King Edward's Building," Newgate Street, E.C. Members will here have the opportunity of gaining first-hand information on the latest methods of ferro-concrete construction.

EASTERN CENTRE.

THE opening meeting of the Session was held at Cambridge on the afternoon of November 2nd, when a lecture was given by the chairman, Mr. J. F. Lamb, on "Artificial Flight."

The subject was introduced by a brief description of the rigid and non-rigid types of airship. The main part of the lecture, however, dealt with the "heavier than air" machine, and was based on an examination of the different makes of aeroplane exhibited at the recent Paris show and an inspection of their performances at the Juvisy flying ground.

Several typical machines were described and compared. The theory of flight and the methods of control of the Wright, Voisin, and Bleriot aeroplanes were discussed.

The papers concluded with a reference to the Wright Bros. patent claims. These are apparently so wide as to be likely to lead to a good deal of litigation.

A keen discussion followed, and the meeting, which was exceedingly well attended, terminated with a very hearty vote of thanks to Mr. Lamb for his most interesting paper.

NORTHERN CENTRE.

A FULL programme has been arranged for the Winter Session, and a very successful season is anticipated.

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The opening meeting was held on the 11th October, when the inaugural address was delivered by Mr. Robb, chairman of the Centre.

There was a good attendance of members, and the chair was taken by Mr. F. Tremain, who happened to be visiting Newcastle on the date of the meeting.

Mr. Robb's address was of a very interesting character. The importance of the routine duties of an engineer's office, and careful attention to matters of detail in engineering works, provided material for an excellent paper. The discussion following the paper was of a high order, and special stress was laid upon the important place taken by the clerical staff in this branch of engineering practice.

The second meeting of the session was held on the 8th November, when Mr. C. Whillis gave an interesting paper on "Ropes and Knots as applied to Telegraph Engineering." The lecture was illustrated by an excellent series of lantern slides. The subject was dealt with in an able manner by Mr. Whillis, and his method of treating the subject maintained the interest of a good attendance of members.

Samples of different ropes were handed round for inspection, and demonstrations given of the make up of different knots and methods of attachment.

On December 13th a paper will be read by Mr. A. G. Lee, B.Sc., on "Graphical Methods of Calculating Mixed Circuits." In view of the high standard of excellence of Mr. Lee's contributions in past Sessions, a paper of outstanding interest is anticipated.

A Whist Drive will be held in connection with the Staff on the evening of the 13th December. Six prizes have been promised, and as the necessary support to the undertaking is duly forthcoming, an enjoyable re-union of the Staff is anticipated.

The Local Centre desire to extend a hearty welcome to Messrs. Sutton, Patterson, McKenzie, and Dunthorne, who have recently been transferred to the Northern District.

SCOTLAND EAST CENTRE.

On the 6th October the members of the Local Centre paid a visit to the Toll Cross Power Station, belonging to the Edinburgh Cable Tramway Company.

The members were greatly impressed with the gigantic machinery in use, in what is believed to be the largest of the few remaining systems of cable traction in this country.

The Council of the Institution of Post Office Electrical Engineers held its session at Edinburgh on the 8th and 9th December.

A meeting of the Local Centre was held on the 8th December, when an interesting paper was read by Mr. C. Crompton on the subject of "Forth Bridge Cables, Past and Present."

SOUTH WALES CENTRE.

Finding the official headquarters somewhat inconvenient for institution meetings, the Local Committee have decided to seek accommodation elsewhere. The office premises are very noisy and, when lectures were in

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progress, it was a common experience for sentences to be overwhelmed in the noise of passing tramcars. Moreover, the clerical office does not lend itself to comfortable seating arrangements, and the Local Committee has for the time being secured a convenient room at the Occidental Café.

A satisfactory feature of the present session, and one worthy of record, is that the membership of the Local Centre has been increased by a return of the clerical staff to the roll of the institution.

On the occasion of the second meeting of the Session, when Mr. A. W. Sirett read an interesting paper on "Building Construction," a visit of inspection was paid to the Lower Penarth Cement Works. About twenty members availed themselves of the opportunity of acquiring a more intimate knowledge of the process of manufacture of Portland cement, and the visit proved to be of a most enjoyable and instructive nature. A detailed account thereof is given in the "Visits to Works" section, written by Mr. P. E. Milford.

Lists of books contained in the Local Reference Library have been printed for distribution in order to serve as local catalogues.

Additional copies may be obtained on application to the Local Secretary

NORTH-EASTERN CENTRE.

The 1909–10 Session opened with the Annual General Meeting, held at the Hotel de Ville, on Saturday, October 9th, 1909, under the presidency of Mr. G. M. Carr.

Considerable discussion arose on the question of the circulation of the technical periodicals, the existing system being severely criticised. A resolution was passed in favour of keeping the number of periodicals at a minimum, and applying the money so saved to the printing and circulation of papers read before the Institute.

The question raised by the Council as to what could be done to stimulate the interest of the clerical staff evoked a great deal of comment. It was suggested that mutual benefit would accrue if an occasional meeting was devoted entirely to the giving of a *resumé* of the latest Head Office practice for the benefit of the Engineers, and that, on the other hand, the clerical force should be kept in touch with the latest Departmental practice as discussed at the periodical meetings of Engineers.

The trouble complained of was thought by many to be due to the present practice of regarding the two classes of officers as independent instead of inter-dependent. The recent withdrawal of the "personal" copy of regulations and circulars was regarded as a retrograde step calculated to lessen the efficiency and interest of the clerical class.

Following the discussion the inaugural address of the Session was delivered by Mr. G. M. Carr. In the course of his remarks he reviewed the progress of the Institution since its inception, and spoke hopefully of its future. Reference was made to the fact that, whilst Aerial Construction, owing to the attention paid to it in the past, no longer offered such a wide scope for suggestion and criticism as heretofore; Underground Work, with its own peculiar difficulties, presented a wide field for the ingenuity of the Engineer.

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As regards Telegraphy, the Wheatstone had been invested with a new lease of life, and Common Battery systems were now engaging the attention of all concerned, having already justified their existence. The enormous growth of the Telephone system, with its consequent demands of economy of space indoors and out, was also dwelt upon, as well as the importance of a high standard of maintenance and the value of the Unit Maintenance Cost.

The speaker pointed out in conclusion that the need of the future would no doubt be in the direction of specialisation, and urged the importance of mastering the principles underlying actions, so that these principles could be applied to new situations when they arose.

At the close of his address, Mr. Carr referred to the promotion, and consequent removal, of Mr. Nicholls to Peterborough. He regretted his departure, but extended to him the good wishes of the staff for his happiness and prosperity in his new sphere. The approaching transfer of the Middlesbro' Section to the Northern District was also mentioned, Mr. Carr saying he was sorry to lose the Middlesbro' staff, but trusted the changes would prove advantageous to all affected.

The second meeting of the Session was held on October 25th, Mr. Carr being in the chair. An excellent paper was read by Mr. W. C. Everatt entitled "Some Notes on Telephonic Speech Transmission." The paper was followed with keen interest by the members present, a fact attested to by the vigorous discussion that ensued.

On the 22nd November a record gathering assembled to hear a paper by Mr. J. C. Butterfield on "The New Wayleave System." The subject was exhaustively dealt with, and the paper proved of real value to all present.

The discussion, which was opened by Mr. F. B. Campbell, was contributed to by a large number of the members.

At this meeting we had the pleasure of meeting our new colleagues transferred from the late North Midland District.

NORTH-WESTERN CENTRE.

At the time of going to press, three meetings of the North-Western Centre will have been held during the present Session.

The first meeting, held on the 4th October, was rendered notable by the fact that the members of the Council of the Institution were present. Mr. Maguire's paper on "Filing" was well received, and in the discussion which followed, members of the Council took part.

At the second meeting held on the 15th November a paper on "Secondary Cells" was read by Mr. Medlyn, and a very interesting discussion followed.

The third meeting which was proposed for the 13th December was moved forward to the 6th December owing to the fact that the two papers scheduled for the former date proved sufficiently long to occupy a whole evening. Mr. Cunningham's paper on "Blackburn Pneumatic Plant" will be contributed on the 6th December, and Mr. Guy's paper on "Transformers" on the 3rd January.

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SOCIAL.

NORTH-EASTERN CENTRE.

A social gathering was held in the Hotel de Ville on Saturday, October 6th. Cards, chess, draughts, etc., were indulged in, the proceedings being enlivened at intervals by songs, solos, and gramaphone selections. The following gentlemen contributed to the harmony of the evening:—Messrs. Farrand, Atkinson, Thornburn, and Kingston, songs, Mr. Butterfield, violin solos, Mr. Clayton, piano solos. The gramaphone was kindly lent and superintended by Mr. Campbell. A most enjoyable time was spent.

NORTH-WESTERN CENTRE.

As a welcome to the Council of the Institution a "tea" was held before the Institution meeting on the 4th October. Our visitors included Mr. A. J. Stubbs, Assistant Engineer-in-Chief, with eight other members of the Council, and there was a representative gathering of the local members. The absence of formality rendered the occasion most enjoyable.

On Monday and Tuesday, the 15th and 16th November, the members of the North-Western Centre visited the Manchester H.P.O., and were conducted over the engine room, the accumulator room, and the telegraph and telephone rooms. In the two latter rooms the Postmaster's representatives were good enough to afford every information and facility that was required, and the thanks of the members are due to the gentlemen concerned.

The opportunities of comparison with other telegraph and telephone apparatus and arrangements were appreciated and taken advantage of.

VISITS TO WORKS.

(*Notes of a visit of inspection paid by members of the South Wales Centre of I.P.O.E.E. to the South Wales Portland Cement and Lime Company's Works at Lower Penarth.*)

GEOLOGISTS are all familiar with the strata of blue lias limestone, shale, and clay, which are so conspicuous a feature of the cliffs between Penarth Head and Lavernock Point in the Bristol Channel—in fact, these strata are commonly known as the "Penarth beds." But not all engineers who have enjoyed marine excursions on the Bristol Channel are familiar with the fact that one of the finest brands of Portland cement is manufactured from those stratified beds, within a quarter of a mile from the shore which the steamers skirt on their summer trips from Cardiff to Ilfracombe.

The Vale of Glamorgan, sometimes called the "Garden of Wales," is covered by the lias beds, and the soil lying on the top of the lias is very rich and fertile. Limekilns may be found all over the countryside where farmers were accustomed to burn lime to put on the land.

Smeaton used Aberthaw lime in the building of his Eddystone Lighthouse, some of which lime was made from the limestone boulders gathered on the beach a few miles west of Penarth, and the remainder was obtained from Watchet, a small seaport on the opposite side of the Channel. Engineers still send to he beaches

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between Aberthaw and Penarth for shiploads of boulders to be burnt into lime on the spot where it is to be used. The works on the cliffs at Aberthaw may still be seen, but they were abandoned by the South Wales Portland Cement Company, who now produce the same material at their more modern works at Lower Penarth.

There are about sixteen works in this country which use limestone and shale from the blue lias formation as their raw material, and of these the works of the South Wales Portland Cement and Lime Company at Lower Penarth are the largest, having a producing capacity of about 1000 tons of cement per week.

Portland cement consists of calcium silicates, aluminates, and ferrites, produced by calcining, or burning in kilns, a mixture containg lime, silica, and alumina in certain proportions and afterwards grinding the resultant sintered mass to a fine powder. The lime is usually derived from calcium carbonate, in the form of limestone or chalk, and the silica and alumina from aluminium silicate, in the form of clay, shale or argillaceous mud. Iron is always present as a non-essential which cannot be conveniently eliminated.

At the above-named works in a quarry situated four hundred yards from the cliffs the raw material, consisting of blue lias limestone, clay and shale is worked. The strata of shale and clay predominate, and whilst the whole of the limestone is utilised about half of the shale and clay has to be abandoned in the workings, as only a certain quantity is required for mixing with the limestone to form cement.

A portion of the limestone is burned in open, basin-shaped, continuous kilns to produce the famous "Aberthaw" hydraulic lime, of which the Company can now supply 600 tons per week.

The staple product of the works, however, is Portland cement, which is all made to conform to the requirements of the British standard specification.

Each bed of shale and stone is worked, hauled, and stacked in drying sheds, separately. Once the exact composition of a bed is ascertained by chemical analysis in the laboratory it is a matter of simple calculation to determine the correct proportions of stone and clay or shale which will be required to produce the standard cement. The material is then weighed and proportioned so as to give a mixture containing 76 per cent. of calcium carbonate, and, in passing through powerful stone crushers, is reduced from lumps of about 1 cwt. each to a size grading from that of walnuts to dust. An elevator next carries this crushed material to a rotary dryer fifty-five feet by five feet, which is heated by coke fires, whence it issues hot and dry. Another elevator carries the material to storage bins over the "mills." From these bins the dry, crushed material is fed automatically to "ball-mills." These are large, "stepped" drums, containing two tons of steel balls, each ball being about five inches in diameter, and it requires no stretch of imagination to believe that these soon grind the stone to a sandy powder. This powder is discharged from the ball-mills automatically into a tube mill (a long tubular mill) containing ten tons of flint balls, which reduces the sandy powder to a fine soft meal. The fineness of this "meal" may be better comprehended when it is stated that the laboratory test is that a sample shall leave but little residue on a sieve with 40,000 *meshes per square inch.* This is the finished *raw* meal, and it now has to enter upon what may be called the second half of the process of manufacture. In its present fine, mobile state it cannot conveniently be subjected to the next process, which is that of "calcining" or burning. In special machines, of this company's own design, it is mixed with about 10 per cent. of water and automatically fed into powerful "briquetting" machines which compress it into bricks, each of about ten pounds weight, convenient for handling.

In passing through these mills it is surprising to note how everything possible in the handling of the material is done mechanically, and the quantities regulated automatically. Even the waste heat from one process is brought into use for another indispensable process.

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The raw material when compressed into bricks has very little cohesive power, so the briquettes are stacked in drying chambers behind the calcining kilns, where the waste heat from the kilns is passed over them, rendering them hard and crisp, so that they may be freely handled with little risk of their breaking without the application of force. For calcining, two kinds of kilns are in operation at these works, ten being of the "intermittent" and four of the "continuous" type. The intermittent kilns are cup-shaped, twenty feet deep and fifteen feet in diameter. They are charged with alternate layers of coke and bricks or "briquets" of the raw cement. A full charge consists of eighteen tons of coke and sixty tons of bricks. Four days are occupied by the process of "burning," and the temperature rises to that of melted *wrought* iron. Of the seventy-eight tons inserted as a "charge" only forty-five tons remain. The residue—called "clinker"—is raked out when cool, and consists of dark greenish-black masses which have obviously been heated to the sintering point. This "clinker" is Portland cement in the unground state.

The continuous kilns are operated in very similar fashion, the essential difference being that they are, as their name implies, *continuous* in action, *i. e.* the bricks of raw cement and the fuel are fed in at the top regularly and continuously and the clinker is just as regularly raked out at the bottom, causing the bulk of material in the kiln to work its way downwards. From the grating on the ground level, to the iron hood or shield above, these continuous kilns are forty feet high. Through doors in the iron shield the weighed and proportioned damp bricks of raw cement and the coke fuel are regularly inserted. The fierce heat in each continuous furnace is maintained by induced draught, *i. e.* the top of the kiln is covered in and all the products of combustion are drawn off by the induced draught, and cool air is drawn through the calcined material which fills the lower parts of the kiln. The electric motors which drive these fans are quite a curiosity in themselves. Their very proximity to the kilns causes them to get very heated ; in fact, upon one occasion the solder in one of the armatures melted and immediately caused a breakdown. To overcome inconvenient repetitions of this incident a very ingenious system of air cooling has been applied to each motor, which is now enabled to draw in cool air from the roof of the building through a three-inch pipe. This air circulates through the working motor and is discharged at a temperature which the passer-by acknowledges to be decidedly warm.

The coke fuel used in the continuous kilns burns in the upper portion of the kiln with an intense heat, and on the surface of the charge is seen the bluish-violet flame of carbon monoxide gas ; the fuel is all consumed long before it has a chance of sinking to the grid of short sections of railway rails at the bottom of the kiln, where the clinker is periodically raked out in small barrow-loads—in fact, the cool air which constantly enters at the foot of the kiln, at the call of the centrifugal fans above, has absorbed all the heat and used it in the process of combustion. Thus the clinker is raked out of the continuous kilns cold and ready for grinding, just as the charges are raked out of the intermittent kilns after time has been allowed for cooling. The *four* continuous kilns have an output of 530 tons per week against an output of 500 tons for the *ten* intermittent kilns—the advantage of the more modern continuous kiln is obvious.

The clinker has now to be ground, and is put through "ball and tube" mills similar to those employed in the raw mill. Although quite cold when fed into this mill, so great is the friction caused by the crushing and grinding that the finished cement issues at a temperature of 180° F. It is so fine that 15 per cent. only is left on a sieve with 32,400 meshes per square inch. In this form the cement is now ready for sale, and travels on automatic conveyers to the stores, which have a capacity of 7000 tons. The stores are divided into compartments varying in size, and of capacities of from 300 to 1200 tons.

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As the fine cement falls out of the chutes into the bins, samples are taken every hour. Other samples are taken from the raw mixture, *i. e.* prior to burning, every twenty minutes. In a well-appointed laboratory, where a staff of five expert chemists are employed, these samples are subjected to chemical and mechanical tests by day and night, which ensure such a close watch upon the whole process of manufacture that it is absolutely impossible for any lack of uniformity in raw material or finished product to escape detection.

Cement is usually made to set in four hours, but this characteristic can be varied in manufacture to meet requirements.

The following table shows the laboratory test for fineness :

No residue	is left	on a sieve with	2,500	meshes	per square inch.
About 0·5 % residue	„	„	5,776	„	„
„ 15·0	„	„	32,400	„	„
„ 20·0	„	„	62,500	„	„

The tensile strength is gauged by the insertion of blocks, cast with one inch square section, in a special testing machine, and the standard attained is that the samples shall carry 600 lb. per square inch when seven days old and about 800 lb. when a month old. Compression tests run up to about ten times the tensile strain, and are so vastly in excess of requirements that they are only occasionally made.

I am indebted to the Company, and to their Director, Mr. W. J. Cooper, in particular, for additional notes upon the process of manufacture.

P. E. MILFORD.

CHESS CLUB NOTES.

THE sixth season of the Engtneering Department Chess Club is now well advanced and is proving as successful socially as last season. Having been promoted to the first division of the league it was not to be expected that as many matches would be won. It was hoped, however, to put up some good fights, and the hope has been realised. Matches with the Patent Office I. and G.P.O. (North I.) have been lost by a narrow margin, but both the Board of Education and the G.P.O. Stores I. have been beaten.

The Club competitions are providing some close and interesting games. We are much indebted to Mr. Probert for very kindly presenting prizes to the winners of the championship and handicap respectively.

A whist drive held in November proved even more enjoyable than that held in March last. The second drive of the season will be held at "Slaters," Newgate Street, E.C., on Thursday, January 27th.

COLONIAL AND FOREIGN NOTES.

CONTRIBUTIONS—more especially short notes of interesting occurrences—are invited from readers abroad.

CORRESPONDENCE.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL, *London*

SIR,—As a distant *contrère* in the T. and T. engineering field I want to appeal to you for a little help, and if you can assist me I will be very grateful. As you

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can easily understand, we in Australia must always look to the Motherland for the latest development in the various branches of our work, and most useful as the JOURNAL is in that respect, it has occurred to me I might find it to my advantage if I could get a correspondent in the English service who would carry on a friendly correspondence. Such a correspondent would be of great value to me, and I might probably be able to give him some interesting notes concerning this country.

Do you think you could pick out a young engineer who would be disposed to correspond with me for mutual interest and improvement? I am a Junior Assistant Engineer and am concerned with both telegraph and telephone branches of our service.

I am happy to say I am a regular subscriber to your very valuable publication, and that it is much appreciated by engineers and others in this country.

Thanking you in anticipation.

[Our correspondent does not wish his name to be published. The Managing Editor will be pleased to forward a communication from any British engineer who may care to respond to this request.]

RETIREMENT OF MR. T. J. WEST.

MR. T. J. WEST retired from the service in November under the age-limit, having completed forty-four years' service.

He entered the Electric Telegraph Company in 1865, and was appointed a telegraphist at Hull at the transfer in 1870, where he remained for eighteen years.

He was successful in getting a transfer to the Engineering Department as Inspector, and was stationed at Newcastle-on-Tyne until 1899, when he was promoted to Assistant Superintending Engineer and removed to the South Wales District, where he remained about two years, and subsequently spent about the same period in the Metropolitan South District.

In 1903 he was selected as Superintending Engineer in charge of the North Midland District.

His retirement has been taken as the opportunity on the part of the Department to disband the North Midland District.

Mr. West was very popular with all members of his staff and took the greatest interest in their welfare, and his retirement was a matter of regret to all who served under him. That he may have good health and live for many years is the wish of all who have been closely associated with him. A. L.

[We regret that pressure on our space prevents the insertion of a most interesting account of the complimentary dinner given to Mr. West at Nottingham on November 6th, 1909.]

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STAFF CHANGES.

BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
Eng'g Dept.	Gunton, H. C.	Prin. Power Engr.	—
,,	Trezise, J. M. G.	Staff Engr., 1st Cl.	Engr., '97; 1st Cl., '98; Staff Engr., 2nd Cl., '04; Asst. Supt. Engr., '08.
,,	Bell, G. W.	Clk., 2nd Cl. (E. in C.O.	S.C. & T. Kendal, '96; Regy. Asst. S.O., '01; 2nd Cl. Exr. T.S.D., '01; 3rd Cl. Clk. E. in C.O., '02.
,,	Lamb, J. F.	Suptg. Engr.	1898; Asst. Supt. Engr., '03; Staff Engr., 1st Cl., '07.
,,	Gomersall, E.	Asst. Suptg. Engr.	Tel., Leeds, '93; Jr. Clk. Eng'g Dept., '96; Clk., 3rd Cl., '98; Engr., 2nd Cl., '00; Staff Engr., 2nd Cl., '04.
,,	Stanhope, J. H.	,,	Tel., Leeds, '81; Sub. Engr., '96; Engr., 2nd Cl., '98; 1st Cl., '01.
,,	Vooght-Cornish, H.	,,	Eng., 2nd Cl., '97; 1st Cl., '06.
,,	Nichols, A. R.	Engr., 1st Cl.	Tel., C.T.O., '85; Sub. Engr. Eng'g Dept., '96; Engr., 2nd Cl., '99.
,,	Laslett, G.	,,	S.C. & T., Folkestone, '85; Tel., C.T.O., '91; Sub. Engr. Eng'g Dept., '97; Engr., 2nd Cl., '00.
,,	Mackintosh, A.	,,	S.C. & T., Inverness, '82; Relay Clk. Eng'g Dept., '96; Engr., 2nd Cl., '01.
,,	Tinsley, W. S.	,,	Tel., Hull, '85; Jr. Clk. Eng'g Dept., '94; Engr., 2nd Cl., '01.
,,	Richardson, G.	,,	Tel., Hull, '85; Jr. Clk. Eng'g Dept., '95; Engr., 2nd Cl., '01.
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ERRATA.

In Fig. 37, page 279, the relay shown to the left of relay R_2 should be designated "R_1."

Following the eighth line on page 268 add the following paragraph :—"Further, the provision of a non-ringing interval during which the tripping relay may be actuated by direct current, ensures the release of relay R_3 at times when the voltage of the generator is low and the resistance of the subscriber's loop high, as under these conditions the response of the subscriber would not provide an alternating current of sufficient strength to operate the tripping relay."

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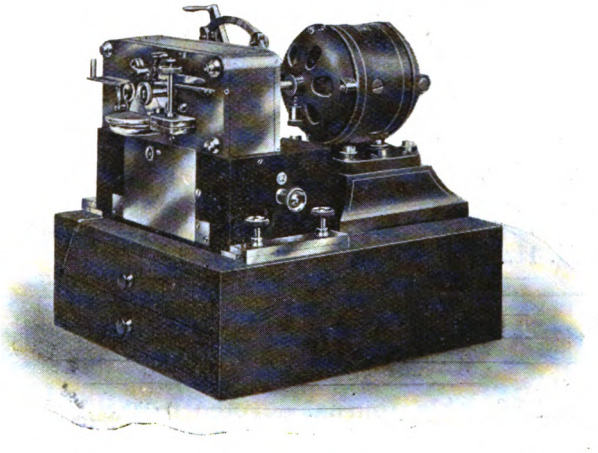

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